POWER

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Bonehead Bill

By Rufus T. Strohm

Our engineer, Bill Jones, last week was surely up against it; a steam pipe sprung a nasty leak — two walls were right fornenst it. And when he got the stop valve shut and made a brief inspection, he found that he would have to cut another threaded section.

But when he set to work with vim in that restricted quarter, he found the job cut out for him a regular rip-snorter. The threading dies were hard to set, as he was quick in learning, and then there wasn't room to get good leverage for turning.

He strained till from his overalls he'd busted all the buckles, and slipped and hit the plastered walls and skinned his tender knuckles. He tugged and grunted, sweat and swore, for nigh to half an hour, until he hadn't any more of patience or of power.

He took a little rest at length, his shirt and jacket shedding, and when he had regained his strength, resumed his job of threading; and so he hauled and sawed and jerked till evening shades descended, and all the next forenoon he worked, before the task was ended.

But when at last he'd turned the trick and screwed the thing together, the steam leaked through in clouds as thick as London's foggy weather. Then Bill just clean forgot the rules of morals and religion, and cussed and damned those threading tools in Russian, Dutch and pidgin.

But though he wildly roared and raved and bent his conscience double, if he'd been wise he might have saved himself a peck of trouble. For what had caused that faulty joint should stir no one to wonder; because — and here's the vital point — those dies were dull as thunder!

The moral of this tale is plain to those who toil and tussle:
A little exercise of brain will save a lot of muscle!

Testing Engines for 40,000 Feet in the Air

How the New Engine-Testing Laboratory at the Bureau of Standards Solves This Problem

By R. S. McBRIDE
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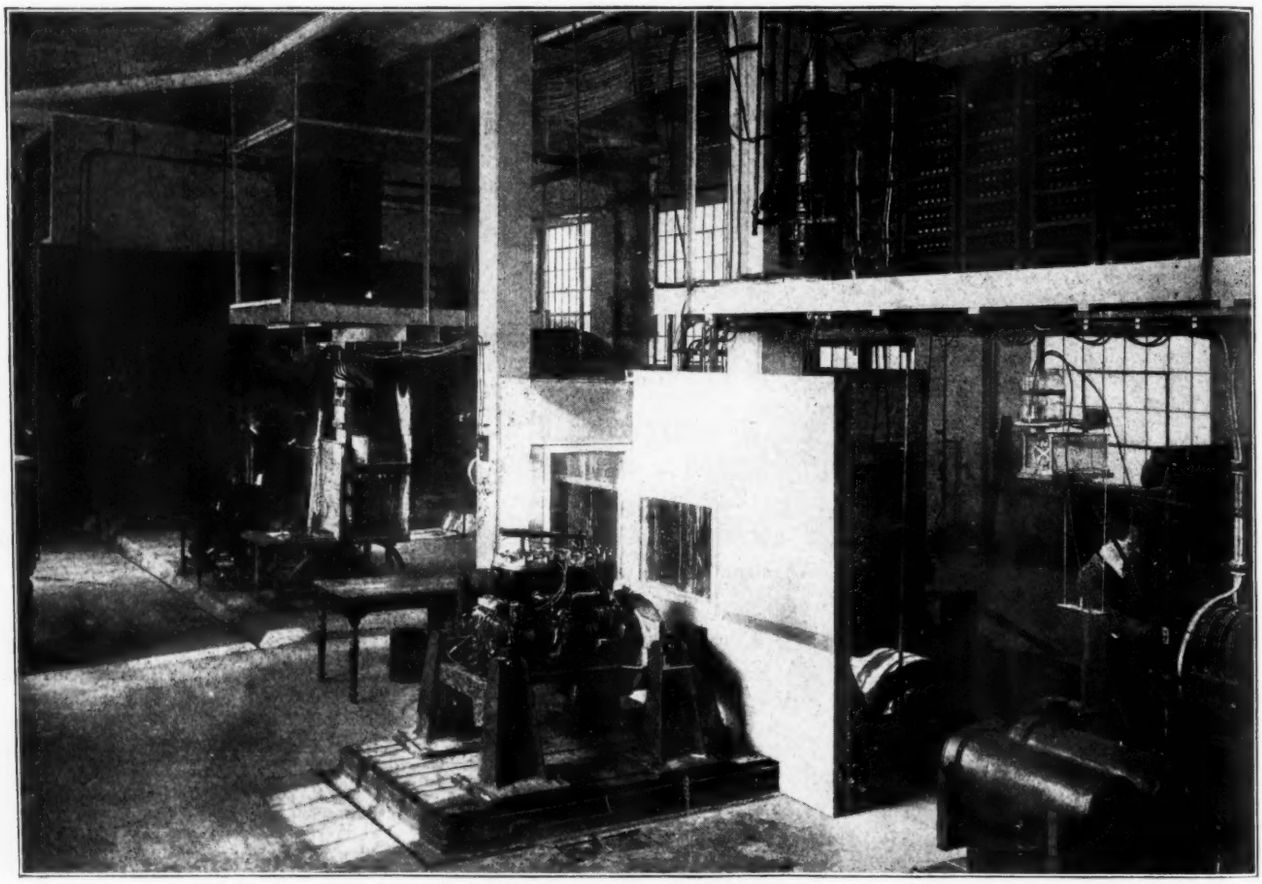
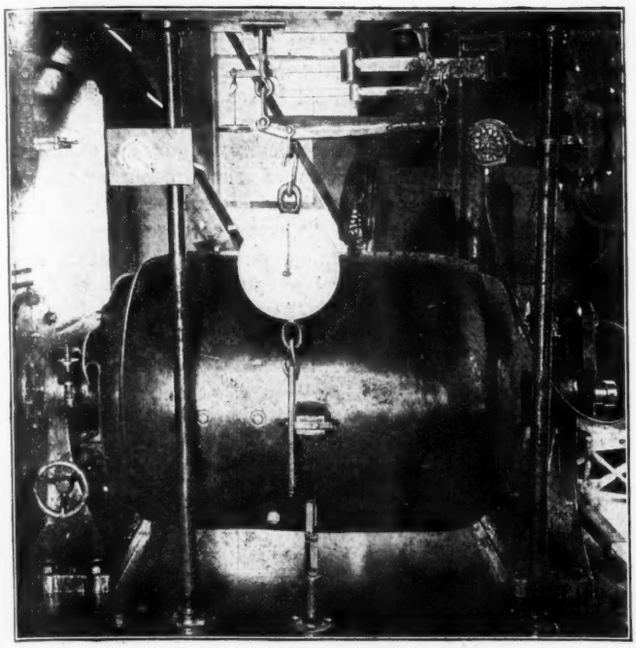
THE Bureau of Standards has developed one of the most complete plants ever built for the testing of internal-combustion engines and, incidentally has made it possible to be safely on the ground with full control of an aëroplane engine, while operating the engine as if it were 40,000 ft. in the air. The new altitude laboratory at the Bureau contains many ingenious and unusual testing devices which are of considerable interest, not only to those interested in gasoline engines, but also to others concerned with any type of power-equipment testing. The work of this laboratory will be of great significance, for many fundamental problems are being investigated.



GENERAL VIEW IN THE BUREAU OF STANDARDS ENGINE-TESTING LABORATORY
The altitude chamber is in the rear at the left. A captured German motor-truck engine is shown on a test block in the center foreground. The racks shown overhead carry the resistance grids used to load the electric dynamometers. The car-dynamometer drums can be seen in the pit at the right.

It is generally recognized that conditions at high altitude are very different from those on the surface of the ground, but it is not usually realized how important these changes are for engine operation. For example, we know that it is necessary to supply an aviator with oxygen so that he may be able to breathe when at high altitudes, but the engine is not provided with any such auxiliary equipment, therefore it is necessary to operate it under conditions that will take advantage of the best possible combinations, otherwise large losses of power and fuel efficiency will be encountered. At 20,000 ft. the atmospheric pressure is about one-half that at sea-level, at 30,000 ft. about one-third sea-level pressure, and the power production of the engine is reduced almost in proportion to the reduction in atmospheric pressure under which it operates. On the other hand, the fuel efficiency at high altitude does not decrease greatly; in fact, the fuel used per horsepower does not change materially until an altitude of 5,000 to 10,000 ft. is reached, after which it begins to increase.

It was because of these general facts that various problems in engine performance had to be investigated as completely as is being done at the Bureau of Standards. The various factors studied include pressure, temperature, operating speed, kind or grade of fuel, gasoline-air mixture, proportions, spark setting, jacket-water temperature, oil temperature, back pressure on the exhaust, throttle opening, mechanical losses and numerous other variables. During the war period this work was housed in temporary buildings,



SPRAGUE ELECTRIC DYNAMOMETER MOUNTED ON SHAFT FROM ALTITUDE CHAMBER

This machine is simply a generator with the field frame mounted on bearings. It is prevented from turning with the armature only by the connection through the scale beam where its turning moment may be measured.

but a new laboratory has just been completed. This is a substantial brick and concrete building about 50 x 150 ft., designed particularly to house large altitude chambers, the car dynamometer and the various parts of the auxiliary equipment.

The altitude chambers, which are the most interesting part of the installation, had to be so designed and built that the atmospheric conditions within them could be adjusted to any condition that might be likely to be encountered at any altitude up to 40,000 ft. Each of the two chambers is 15 ft. long by about 7 ft. wide and 7 ft. high. They are thus of ample capacity for the largest aëroplane engines. The chamber is built up of reinforced concrete, 12 to 14 in. thick on four sides, top and bottom, in order to resist the great crushing force which is developed when the pressure within the chamber is reduced to a quarter or a third of that without. For thermal insulation the walls are lined with a two-inch cork layer. Access to the chambers is had through large counterweighted doors which slide up out of the way and permit free access either for installation or working about the engine under test. The engine itself is mounted on a heavy wooden frame, which has been designed to be as nearly as possible of the same flexibility and inertia characteristics as the typical aëroplane fuselage mounting. The pressure within the chamber is reduced to any desired point by a Nash hydroturbine-type vacuum pump which has a rated capacity of 1,500 cu.ft. of air per minute, when operating against a 12-in. vacuum at 300 r.p.m. This exhauster is belt-driven by a 75-hp. motor. This apparatus is capable of lowering the pressure to that normally existing at 30,000 to 40,000 ft. altitude or, in other words, about one-third to one-fourth of an atmosphere. The air circulated through the chamber and that supplied to the engine intake are cooled by passing over refrigerating coils. These coils are operated in connection with a York ammonia compressor using the direct ammonia expansion system. The refrigerating machine has a rated capacity of 25 tons and is operated by a 50-hp. motor. All this equipment is duplicated for the companion chamber. The air for the engine intake is cooled in a separate set of coils and controlled separately throughout. The temperature in the chamber as a whole can be lowered to about 0 deg. C., but the intake air can be cooled to —25 deg. C. The air to the engine, after passing over its cooling coils, goes through a settling chamber in order to eliminate the fine snow that is often carried in suspension. From here it is metered by three venturi tubes arranged in parallel and passes through control valves to the engine intake.

The exhaust from the engine is cooled as rapidly as possible by water jackets around each exhaust outlet. After this preliminary cooling in the water jacket, the exhaust gases and the cooling water mix together in the exhaust manifold, are drawn out into a separating tank, and the exhaust gases are taken from there by the large vacuum pump and discharged outside the building. The air circulation in the chamber is arranged for with fans appropriately installed to direct the air current over the cooling coils and around the engine. It is estimated that this system will be adequate even to care for tests of air-cooled engines, though none of this type of equipment has yet been tested.

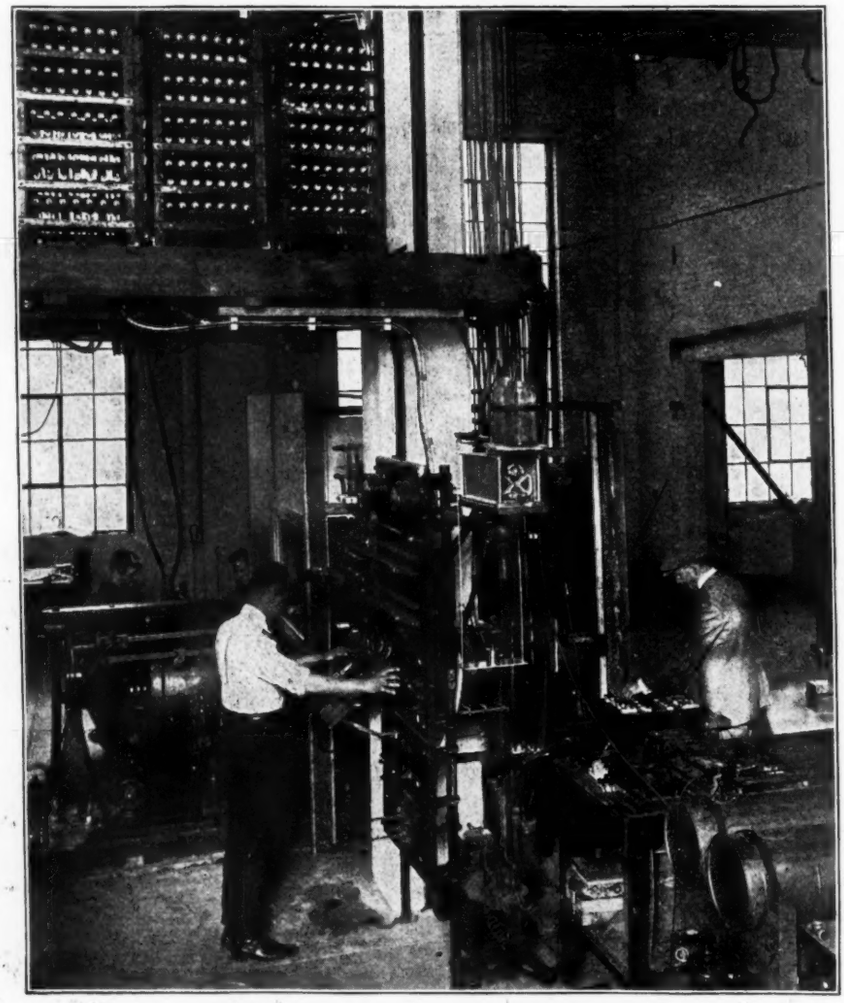
The two altitude chambers are connected together through a small vestibule, thus permitting the use of either set of cooling coils or both, as may be required;

TESTING A UNION ENGINE FOR THE NAVY DEPARTMENT

Note the pipe overhead for carrying the engine exhaust to the large vertical pipe or stack.

but either chamber can be operated independently of the other, thus permitting tests on one engine to be in progress while another is being set up in the other chamber.

The power delivered by the engine is measured by a combination electric dynamometer and water-brake system. On one of the chambers two dynamometers, each of 300 hp., and a 400-hp. water brake are connected together in such a manner that the indications of all three can be weighed upon a single scale. Thus a total of 1,000 hp. can be measured directly by a single indicating mechanism. The other chamber is equipped with one 400-hp. dynamometer to which a water brake of any desired capacity can be added in case of need. The power developed by the dynamometers can be dissipated by resistance grids alone, or it can be used in operating the auxiliary motors and the balance absorbed in the resistance grids, which are then allowed to float upon the power line. For practical purposes, however, the best experimental results are found when all the current generated in the dynamometer is dissipated through the resistance grids, because in this manner the most uniform and controllable conditions for tests are obtained. One very great advantage in the installation of the new laboratory is the arrangement of the controls for the engine, the air system and the dynamometers, all of which are brought near together so that a single operator has complete control of the system without moving from his regular position of observation. It is thus possible to adjust conditions for a test, carry through the observations and be ready for a new adjustment. The complete determination of a heat balance in the system requires determination by weighing of the fuel used and an estimation of the heat gained in any combustion of lubricating oil, which together make up the total energy input. The output of energy is distributed over the brake horsepower, measured by the dynamometer system, the heat lost in the exhaust, the heat lost in the jacket water, the heat lost by direct radiation, and any mechanical losses. All these quantities depend upon the temperature, density of the air and many other factors. Practically a complete calorimeter system has been developed for measuring these different losses when complete determination of the heat balance is required. Temperature measurements are taken regularly at many points throughout the system, not only for control purposes, but also to furnish data for these thermal calculations. A recent report of the laboratory summarizes a dozen of the more important tests which have been carried through already at this Bureau. The following list indicates the scope of this work, some of which is still under way:



TEST ON A ONE-CYLINDER LIBERTY ENGINE

These tests were made to study the rate of flame propagation in the engine cylinder under different conditions. The operator at the left is at the dynamometer switchboard controlling the load on the dynamometer. The operator at the right is adjusting the spark chronograph which measures the speed of flame propagation.

1. Horsepower-altitude relation for engines at normal speed.
2. Horsepower-speed relation over a range of altitudes up to 30,000 feet.
3. Horsepower - compression ratio for normal speed, using compression ratios of 4.7, 5.3, and 6.2 to 1 over a range of altitudes up to 30,000 feet.
4. Horsepower-inlet air temperature over a range of speeds and altitudes.
5. Effect of variation of intake pressure on horsepower over a range of altitudes, to simulate the effect of supercharging equipment.
6. Effect of exhaust back pressure on horsepower, over a limited range of pressures.
7. Mechanical losses at various speeds, altitudes and engine temperatures.
8. Metering characteristics of a number of different types of carburetors, with and without altitude compensation or control, for the full range of speeds and altitudes.
9. Best mixture ratios for maximum power over the range of speeds and altitudes, with different carburetors.

10. The performance of a number of automatic and hand-operated altitude compensation devices for different carburetors.

11. The total heat distribution for all speeds and air densities at full throttle.

12. The performance of special fuels: "Hector," a combination of cyclehexane and benzol; "Alco-gas," a combination of alcohol, benzol, gasoline and ether, at a compression ratio of 7.2 to 1.

One of the problems still giving considerable difficulty in the aëroplane-engine field is the question of carburetor adjustment with changing atmospheric pressures. The automatic arrangement for adjustment with changing speeds is not satisfactory for altitude changes. For example, in some of the early work it was found that at higher altitudes four times as much gas was delivered as was found at ground-level conditions unless readjustment was made. A number of ways for controlling this factor have been devised, two or three of them the inventions of the aëroplane-engine section of the Bureau of Standards. However, hand control of this adjustment is still general since none of these automatic devices has yet found wide-spread application.

The problem of "supercharging" for altitude work has been studied by these laboratories only in a preliminary way, but it is expected that further work will be undertaken shortly. This is one of the very important problems in automotive work, and its investigation promises to give important results. A determination of the best compression ratios for various altitudes is in active progress. This is important as affecting the fuel efficiency and also the power production at a given speed.

One interesting fact that is pointed out as the result of these investigations is the influence of temperature upon power production. Fuel efficiency is not greatly affected by temperature, but even with high-grade liquid fuels the power developed by an engine is largely affected. With the better grades of gasoline the power output is greater with slightly lower temperatures, but when temperatures too low for effective vaporization are reached, the power output again falls off. The magnitude of these effects and means for their control are of extreme importance in aëroplane-engine work, though also of considerable significance for all automotive construction.

Not content with studying the altitude effects, this laboratory has also developed an elaborate dynamometer system for car, transmission, axle and engine testing. By various combinations of dynamometer, water brake and prony brake this apparatus can determine the effectiveness of operation under all varieties of conditions or of any part of the system. The engine itself, the transmission system, the differential and even the power delivery on the road, as judged by the application of tire or service wheel to the drum, can be separately studied.

For this work three dynamometers having capacities of 50, 125 and 150 horsepower, respectively, are installed on three sides of a rectangular pit in which the drum and transmission outfit is placed. Extensive tests of lubrication and differential problems will be possible with this outfit, since any one of the three dynamometers can be used as a measuring or as a driving unit.

Each of these three dynamometers can also be used separately for independent investigations. For example, one of them is now being used in connection with tests on a one-cylinder Liberty engine built to study the rate of flame propagation within the cylinder while operating.

The means of determining rate of flame travel within the cylinder is very effectively developed here by a triple spark-plug system. At the time the flame of burning gas-air mixture passes over the spark plug, the gases are ionized and a reduction in electrical resistance results. This permits the passage of a spark across the gap. These spark plugs are connected to a spark chronograph or an oscillograph, and the relative time of passage of the flame past these three points can thus be measured. A full description of this particular installation has been given by MacKenzie and Honaman in the *Journal of the Society of Automotive Engineers* for February of this year.

Chart for Finding Power Factor

By C. Harold Berry

IN THE switchboard equipment of modern alternating-current power plants the power-factor meter is being displaced by the wattless-component meter owing to the fact that the reliability of the former is limited to restricted conditions, whereas the latter is reliable over a much wider range. In spite of the superiority of the wattless-component indicator, the power factor is what we wish to determine. Wattless component in itself means nothing, but it must be considered in its relation to the actual kilowatts, and this relation is expressed by the power factor.

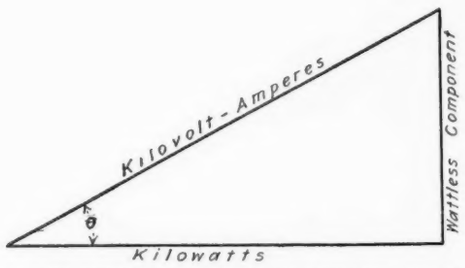


FIG. 1. RELATION BETWEEN KILOWATT, KILOVOLT-AMPERES AND WATTLESS COMPONENT

As is well known, the relations between kilowatts, kilovolt-amperes, and wattless component are those of the three sides of a right triangle, as shown in Fig. 1. We thus have the following relations:

$$P.F. = \frac{KW.}{KV.\text{-}A} = \cos\theta \,.\, WC = KW. \tan\theta = KW. \times \frac{\sqrt{1 - P.F.^2}}{P.F.}$$

where $P.F.$ equals power factor, $KW.$ equals kilowatts, $KV.\text{-}A$ equals kilovolt-amperes and WC equals wattless component.

The last equation is awkward to solve, so the easiest way to get the power factor from readings of kilowatts and wattless component is to make use of tables of trigonometric functions of angles. Since the tangent of the angle θ equals the wattless component divided by kilowatts, we may perform this division and then look up the angle in a table of natural tangents. Having thus found the angle, we may turn to the table of

natural cosines and read off the cosine of the angle, which is the power factor.

Even this process is tedious and slow, especially where such computations must be made by switchboard operators on regular hourly of half-hourly readings on several machines, and the alignment chart of Fig. 2

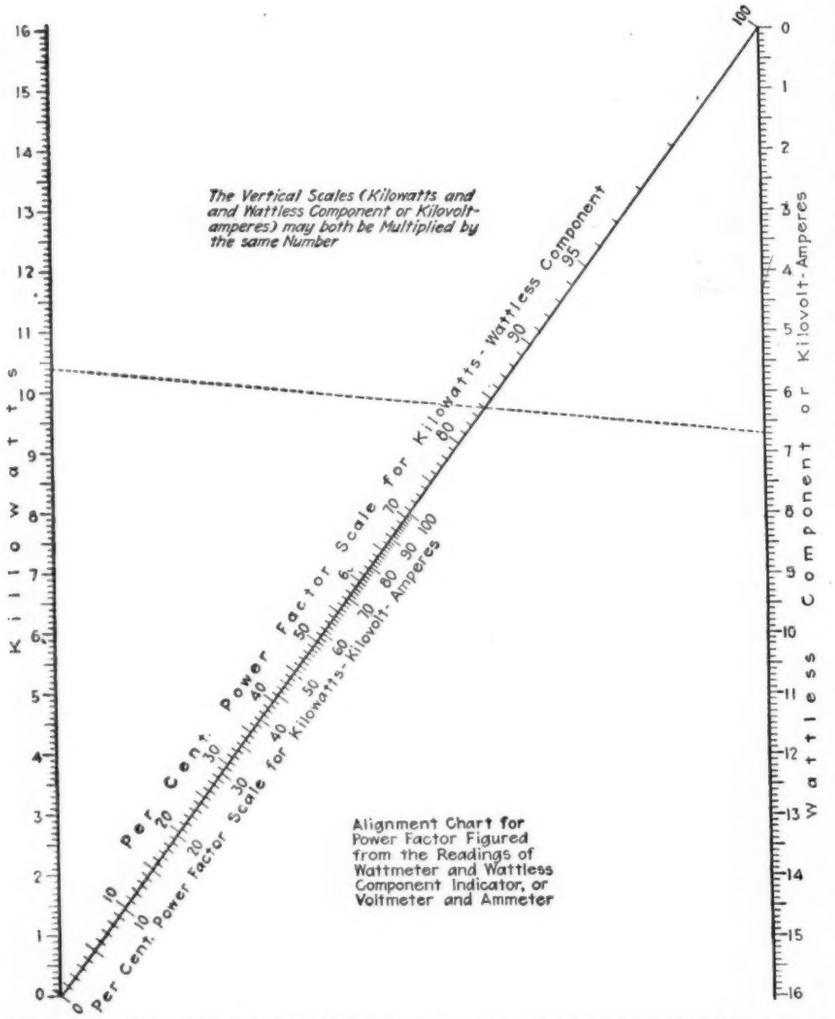

The Vertical Scales (Kilowatts and and Wattless Component or Kilovolt-amperes) may both be Multiplied by the same Number
Kilowatts
Wattless Component or Kilovolt-Amperes
Per Cent. Power Factor Scale for Kilowatts-Kilovolt-Amperes
Per Cent. Power Factor Scale for Kilowatts-Wattless Component
Alignment Chart for Power Factor Figured from the Readings of Wattmeter and Wattless Component Indicator, or Voltmeter and Ammeter

FIG. 2. CHART FOR CALCULATING POWER FACTOR FROM KILOWATTS AND WATTLESS COMPONENT OR KILOWATTS AND KILOVOLT-AMPERES

has been designed to give the desired result quickly and accurately without calculation or reference to tables.

The use of this chart will be almost obvious. On the left-hand scale find the point representing the kilowatts, on the right-hand scale the point representing the wattless component. Through these two points pass a straight line — a stretched thread or a line scratched on a sheet of celluloid. At the point where this line cuts the diagonal of the chart, read off the power factor from the scale on the upper side of the diagonal.

For example, if the kilowatts is 10,400, and the wattless component 6,700, the power factor will be 84 per cent, as indicated by the dotted line drawn on the chart.

In using this chart, both vertical scales may be multiplied by the same number. By this means the line joining the two given points may be made to intersect the diagonal nearly at right angles, thus making it easy to read the chart. For example, if we have kilowatts equal to 19,000 and wattless component 17,000, the line drawn through the points 19 and 17 as numbered on the chart intersects the scale at a very small angle, and it is difficult to read the power factor. We may get the same result, however, by passing a line through 9.5 (half of 19) and 8.5 (half of 17), which enables us to read the result as 74.5 per cent power factor. On the lower side of the diagonal has been added a scale for obtaining the power factor from the kilowatts and kilovolt-amperes. For example, if the kilowatt meter reads 551 and the kilovolt-amperes as determined from the voltmeter and ammeter readings is 650 then a line drawn from 6.5 on the kilovolt-amperes scale to 5.5 on the kilowatt scale will give a power factor of 85 per cent. This might just as easily be determined on the slide rule, so that there is no special advantage in having this scale on the chart. However, it does not interfere with the other scales, and may at times prove useful.

White Coal Available in Canada

The Committee on Water Power of the Commission of Conservation of Canada, following a survey of the total available water power of that country, reports that Quebec has 6,000,000 available horsepower; Ontario, 5,800,000; British Columbia, 3,000,000; Manitoba, 2,797,000; and a considerable amount of power in other parts of the Dominion, totaling in all, 18,832,000 horsepower.

It is estimated that more than 85 per cent of the total electric-generating-station capacity in Canada is derived from water power, the remainder being nearly all steam power. Efforts toward more complete utilization of this power are under way Last year there was completed throughout the Dominion installation of plants aggregating 64,000 hp., and plants at present under construction total over 370,000 hp., while other developments planned for the future will increase this by about 750,000 horsepower.

Two methods, entirely different, have been developed for dealing with water-power problems in Ontario and Quebec. Each seems to be successful in its own area. The Hydro-Electric Power Commission of Ontario has jurisdiction over all water powers in that province. The commission is carrying out its own developments and operating its projects. In Quebec the Quebec Streams Commission is taking all necessary steps to make water power available by private companies. The commission undertakes the building of dams and all the work necessary so that the proposed power-plant sites will be for use, but the companies obtain leases for the use of water, build the necessary generating plants and operate them.

Design and Construction of Power-Plant Piping

Practical Suggestions Regarding the Design and Construction of Power-Plant Piping, Including Materials Used, Valves, Fittings and Types of Joints for Various Pressures and Temperatures

BY JOHN D. MORGAN

IN THE design of a power-plant piping system the first task is to make up a sheet showing the lines to be constructed.

A specimen sheet is shown in the table giving practically all the lines that are used in the average power plant. These lines can be classified into groups, as follows: High-pressure saturated and superheated steam piping; exhaust-steam piping; atmospheric exhaust piping; feed-water piping; low-pressure water piping; blowoff piping; drips and drains; oil piping, high- and low-pressure.

The design of the high-pressure steam piping system will demand much attention, for with the advent of high steam pressure and high degree of superheat and the use of large turbines, it is necessary that the line deliver steam with the smallest possible pressure variation from its original boiler pressure and also at the highest possible temperature.

PIPING LINES IN POWER PLANTS

STEAM LINES:

Main high-pressure superheated steam line.
Duplicate high-pressure superheated steam line.
Auxiliary high-pressure superheated steam line.
Main high-pressure saturated steam line.
Duplicate high-pressure saturated steam line.
Auxiliary high-pressure saturated steam line.
Main exhaust steam line.
Auxiliary exhaust steam line.
Atmospheric exhaust steam line.
Atmospheric exhaust from feed-water heaters.
Atmospheric exhaust from blowoff tank.
Line to damper regulator, whistle, etc.

WATER LINES:

Discharge and suction lines of boiler-feed pumps.
Discharge and suction lines of condenser circulating pumps.
Discharge and suction lines of vacuum pumps.
Discharge and suction line of fire pumps.
Discharge and suction line of house-service pumps.
Discharge and suction lines of hot-well pumps.
Discharge and suction lines of water cooling pumps.
Discharge and suction lines of sump and miscellaneous pumps.
Discharge of condensers.
Lines from surge tanks to feed-water heaters.
Overflow lines from feed-water heaters.
Lines to boiler balanced-draft systems.
Lines to and from venturi and V-notch meters.
Flooding lines to and from superheaters.
Lines to and from turbine glands.
Lines to and from air cylinder on air compressors and dry vacuum pumps.
Condenser priming lines.
Centrifugal pump priming lines.
Ash sprinkling lines.
Fire lines.
Overflow from hotwells and tanks.
Discharge from steam traps.
Lines to and from water-cooled transformers.
Lines to and from boiler-compound mixing tanks.
Lines to and from washing machines.

DRIPS AND DRAINS:

Lines from turbines and engines.
Lines from boilers and superheaters.
Lines from auxiliaries.
Lines from all pumps.
Lines from steam and water mains.
Lines from feed-water heaters and separators.

BLOWOFF PIPING:

Lines from boilers to blowoff tanks.
Lines from feed-water heaters and safety valves.

AIR PIPING:

Lines from condensers and air pumps.

GAGE PIPING:

Lines to all gages, mercury columns, recorders, etc.

GAS PIPING:

Lines for light and heat.

SMALL PIPING SYSTEMS:

Compressed-air system.
Step-bearing oil system.
Hydraulic-gear oil system.
Turbine-oiling system.
Engine-oiling system.
Fuel-oiling system.
Boiler feed-pump regulator pipe.
Refrigeration system.

The formulas most generally used are those of Babcock, which are as follows:

$$W = 87\sqrt{\frac{P\,c\,d^5}{L\left(1+\frac{3.6}{d}\right)}}$$

$$V = \sqrt{\frac{Pd}{cL\left(1+\frac{3.6}{d}\right)}} \times 15{,}951$$

$$P = 0.0001321\frac{W^2L+\left(1+\frac{3.6}{d}\right)}{cd^5}$$

Where

W = Weight of steam flowing in pounds per minute;
L = Length of pipe in feet;
P = Drop in pressure;
d = Diameter of the pipe in inches;
c = Density in pounds per cubic foot of steam;
V = Velocity in feet per minute.

In close calculations it is necessary, when the drop in pressure is a determining factor, to figure on the resistance of bends and valves in the system. For this work Briggs formulas for the equivalent resistance expressed in feet are most generally used. They are as follows:

For 90-deg. bend

$$L = \frac{76\,d}{\left(1+\frac{3.6}{d}\right)\times 12}$$

For globe valve

$$L = \frac{114\,d}{\left(1+\frac{3.6}{d}\right)\times 12}$$

For special conditions it frequently becomes necessary for the designing engineer to figure the resistance of pipes to internal and external pressure. The formulas which lend themselves with greatest accuracy for the collapsing pressure are Stewart's. These are as follow:

$$P=1{,}000\left[1-\sqrt{1-1600\left(\frac{t}{d}\right)^2}\right], \text{ or } P=86{,}670\,\frac{t}{d}-1{,}386$$

Where P is the pressure in pounds per sq.in., t is the thickness in inches and d is the outside diameter in inches. When the ratio of t to d is less than 0.23, the first formula should be used, the second for all other cases.

The formula most used for the bursting pressure is that of Barlow:

$$P = \frac{ft}{r2}$$

Where P is the pressure in pounds per square inches, f is the ultimate unit stress in pounds per square inch, t is the thickness in inches and $r2$ is the outside radius in inches.

One part of the design that must be given very careful consideration is the branch lines from the main. It is essential that the sum of percentages of the carrying capacities of the branches be 100 per cent or more.

The general engineering custom in regard to the velocity of steam in the high-pressure mains is to use from 6,000 to 7,000 ft. per min. for saturated steam and from 10,000 to 12,000 ft. per min. for superheated steam.

The two materials that are most used are steel and wrought-iron pipe. When no accurate figures are at hand the ultimate strengths of the various pipes can be taken approximately as follows: Butt-welded steel pipe, 40,000 lb. per sq.in.; lap-welded steel pipe, 50,000 lb. per sq.in.; seamless-steel pipe, 60,000 lb. per sq.in.; wrought-iron pipe, 28,000 lb. per sq.in.

For high pressures and temperatures there are several types of valves that are suitable for use. These are the double-seated poppet-type valve, the globe or angle type with outside stem and yoke, and the solid-wedge or broken-wedge gate valve with outside yoke. Most of the valves in general use are of the last-mentioned type; however, the first two are in many respects better valves, for if the machine work is not done in a thorough manner and the right quality of metal used, the gate valve will leak more freely than the other two. It is customary to have all large valves equipped with bypass valves to equalize the pressure on both sides. Various types of flanges are in use. These vary as to actual design with the type of joint with which they are intended to be used. For instance, different types will be required for the screwed joint, welded joint, vanstone joint, the ground joint with cast-iron gasket ring and the expanded joint. The various materials used in flanges are cast iron (standard weight for 125 lb. pressure and extra-heavy for pressures up to 250 lb.), semi- or ferro-steel of standard and extra-heavy weights, cast steel of extra-heavy and standard weights, rolled steel and forged steel.

The field for the screwed joint is not that of high pressures and temperatures; however, the screwed joint is not unsatisfactory when the joint with welded flanges and the cast-iron gasket ring is a good one, provided good workmanship is secured, but as a rule it is difficult to secure this workmanship. From a manufacturing viewpoint the welded joint is superior, but in the field for erection its great rigidity is its greatest drawback, and if the vanstone joint is made, using care in its manufacture, and is made with the high hub, improved reinforced square corner with raised surfaces from the inside of the bolt circle to the inside of the axis of the pipe, there can be no question as to its superiority.

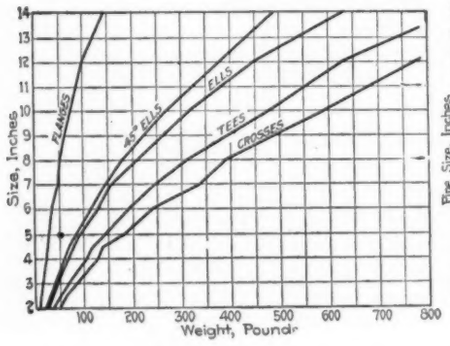


FIG. 1. WEIGHT OF CAST-IRON FLANGED FITTINGS, FOR 2 TO 14-IN. PIPE

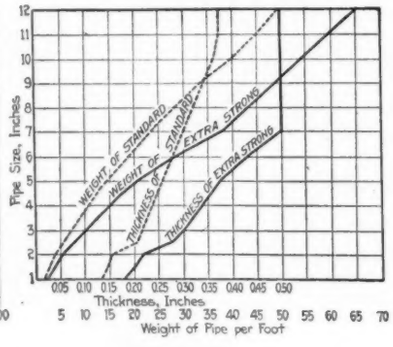


FIG. 2. THICKNESS AND WEIGHT OF STANDARD AND EXTRA-STRONG PIPING

There has been developed a joint where the pipe is rolled into recesses in the flange. This joint is quite satisfactory, but it has not been generally used. Then there has also been developed a joint that does not make use of any regular flange. The pipe is rolled back similar to that of the vanstone except that the metal turned back is thicker than the thickness of the pipe and holes are drilled into the turned-back flange and the pipes are bolted together with a gasket between them. This joint is very satisfactory and reduces the weight of the installation considerably. There has also been used a joint where the pipe has been flanged over like the vanstone except that the flange has been recessed with an angle cut on the outside and the pipe flange has been rolled back into the angle. This joint is satisfactory, but does not approach the vanstone joint for flexibility in erection.

Gaskets that are suitable for use with superheated steam are many. The one in most general use is the soft corrugated steel gasket applied with a cement. There also are a number of other good varieties, such as the asbestos gasket shrouded with copper or bronze and the corrugated copper gasket. The important point in connection with gaskets is their proper installation, and this is accomplished only when the bolts are drawn up tight and uniform over the complete bolt circle.

The fittings most generally used consist of tees, ells, Y's, crosses and laterals. These are made of cast iron, malleable iron, semi- or ferro-steel and cast steel of standard and extra-heavy weight. In the most modern plants it has become standard practice to eliminate fittings wherever possible. This is accomplished by the use of welded nozzles on the pipe. These nozzles can be of any length or size with any type of flange or joint, and their use lightens the total weight of the piping and eliminates from 50 to 60 per cent of the total joints. Fig. 1 graphically shows the weight of cast-iron flanged fittings, and Fig. 2 indicates the thickness and weight of standard and extra-heavy piping.

For high pressures and temperatures there are two types of expansion joints that are suitable—the slip-type joint with a proper packing, and pipe bends. The corrugated reinforced copper expansion is not suitable for superheated steam. Of the pipe bends there are several types—the quarter bend, the U-bend, combination U and quarter bend, expansion U-bend and the double-offset expansion bend. Assuming 1 as the proper expansion for the quarter bend, then the relative expansion values of the other bends are as follows: U-bend, 2; combination U and quarter bend, 4; the double-offset expansion bend, 5. In the design of bends the radius and the weight of the pipes must be properly proportioned in order that the right amount of expansion and contraction can be compensated for without damage to the piping or bend.

The use of superheated steam at high temperatures and pressures has given rise to spirited discussion in regard to the materials most suitable for fittings, flanges and valves in connection with piping systems. Recently, the A. S. M. E. Boiler Code was revised in relation to cast iron and superheated steam, as follows:

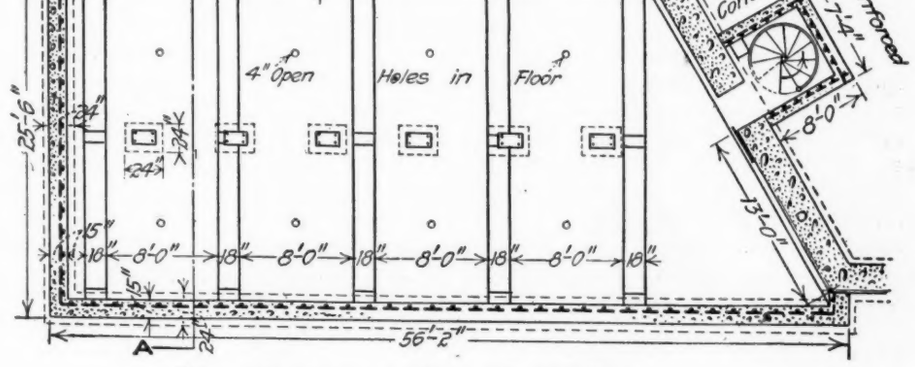
Cast iron shall not be used for nozzles or flanges directly attached to the boiler at any pressure or temperature. Cast iron shall not be used for boiler or superheater mountings, such as connecting pipe, fittings, valves and their bonnets for steam temperatures over 450 deg. F.

No mention is made in the Code for the piping systems at large. At a more recent date the United States Steamboat Inspection Service authorized the use of semi-steel gray-iron mixture for superheater headers on ships, and Lloyds have also adopted this ruling. This shows a diversity of opinion. These various rulings have been made after considerable discussion on the subject, and it is the general opinion among well-known engineers that much of the trouble experienced with extra-heavy cast-iron fittings and valves, when operated at temperatures not exceeding 500 deg. F., has been largely due to the design rather than to the character of the material. Abroad, the use of cast iron of a grade called gun iron has given very good success, although it is generally conceded that for high steam pressures and for temperatures in excess of 500 deg. F. steel fittings should be used. Cast iron, when subjected to temperatures in excess of 500 deg. F., does in some cases show a permanent increase in some dimensions. How long this growth would continue is uncertain, also that the strength of cast iron is materially reduced when exposed to temperatures not exceeding 550 deg. F. has not been conclusively proved, and as a matter of fact some engineers claim that the strength of cast iron grows till it reaches the break-down point around 800 deg. F. It seems probable that most of the failure of cast-iron fittings in stationary plants where the temperature does not exceed 500 deg. F. has been due to poor quality of the cast iron, variable temperature of the steam, poor design of the piping, fittings and flanges, or the lack of sufficient expansion joints. This is borne out by the fact that there are in this country over 37,000 locomotives that have cast-iron superheater headers and steam pipes operating every day with temperatures from 600 to 750 deg. F., and they undergo greater stresses and more sudden temperature changes and fluctuations than any stationary power plant would ever be subjected to, and failures of these headers and steam pipes due to the high temperatures used are practically unknown. It would certainly seem from all reliable information that the use of a high grade of cast-iron fittings is permissible for temperatures of about 500 deg. F. and that steel fittings are advisable for higher temperatures. However, many advocate the use of steel fittings in all cases, because a greater factor of safety is afforded and also because poorly designed systems using steel fittings will not be so likely to have trouble. But the fact remains that the use of cast-iron and semi-steel fittings for a certain limited temperature is by no means poor engineering practice.

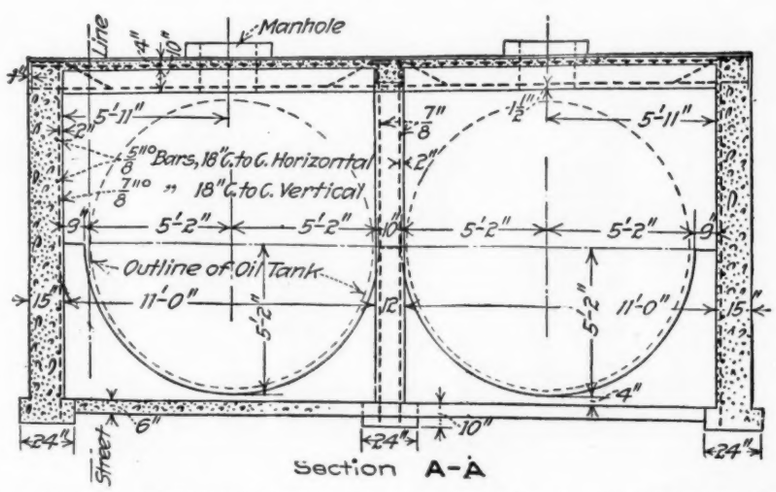
The material best suited for valve seats, discs and bushings is nickel or monel metal. These metals have practically the same expansion and contraction as steel, and temperatures up to 1,000 deg. F. have no material effect on the seats, discs and bushings made of these metals. The valve stems should be made of nickel steel. Brass or bronze is unsuitable for use with superheated steam of high temperatures. At temperatures approximately 650 deg. F. the breaking strength of bronze is only about 12,150 lb. per sq.in., and its elongation at this temperature is only about 1½ per cent. At normal temperatures its elongation is about 37 per cent and it has a breaking strength of 34,000 lb. In regard to the metal for the body of the valve, the same conditions apply as to that for fittings.

Fuel-Oil Tanks, Tamarack Mills

Through the courtesy of Jenks & Ballou, consulting engineers, Providence, R. I., is reproduced the working drawing of the concrete pits housing the steel fuel oil tanks at the Tamarack Mills power plant, Pawtucket, R. I. *Power* readers will welcome this drawing.

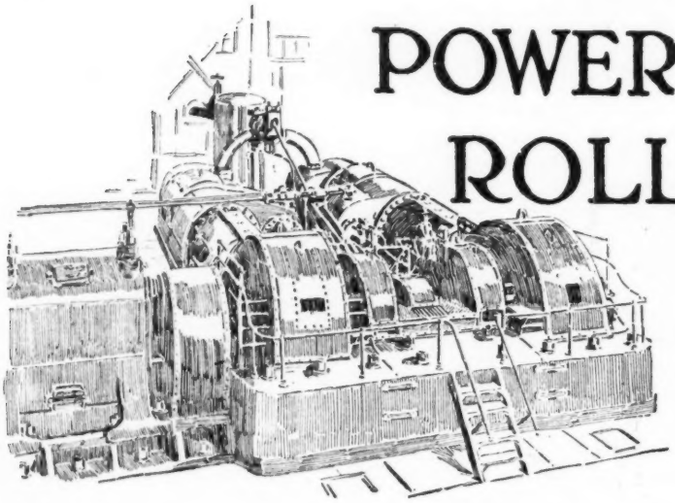


Plan showing Location of Cradles



Section A-A

PLAN AND SECTIONAL VIEWS OF FUEL-OIL TANKS AT TAMARACK MILLS



POWER DRIVES FOR ROLLING MILLS

By

W. O. ROGERS

Various types of engine valves are touched upon as applying to rolling-mill units. Two of the largest poppet-valve uniflow engines in the world were found operating a 9- and 12-in. merchant mill. These engines operate condensing, and have disc-driven governors so designed that the engine speed can be regulated while the engine is in operation.

BEFORE taking up the uniflow engines that I saw used for driving rolling mills, it might be well to mention the action of the various types of valves used on engines that were described in the preceding article. Of the ordinary slide valves there are several types, including the flat or D unbalanced valve, not much used in rolling-mill practice; piston valves, which by the nature of their form are balanced; pressure-plate valves, which are balanced by special form of plates; riding cutoff, which are usually flat valves, each being operated by a separate eccentric; gridiron valves; and rotating valves. The D-valve is the simplest type used. Steam is admitted to the cylinder past the two outside edges and exhausts to the atmosphere past the two inside edges to a common exhaust port. It is generally made with steam laps so that the steam edge of the valve will overlap the steam edge of the port when the valve is in its mid-position. The steam lap is provided mainly to cut off the steam supply to the cylinder, generally at about three-quarters of the piston stroke. Steam lap also permits of free exhaust. Pressure-plate or balanced valves operate with a plate that rests against the back of the flat valve and excludes the steam pressure from all or part of the top of the valve, which causes it to be balanced with only a sliding friction, due to its own weight. The action of the steam in passing the valve is practically the same as with the D slide valve.

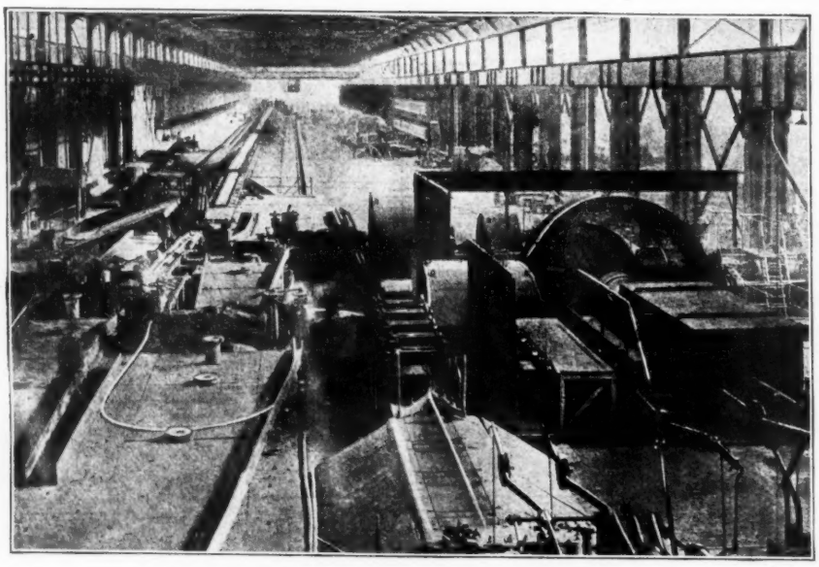


FIG. 1. THE 9-IN. MERCHANT MILL AT THE STRUTHERS PLANT

The piston valve is a simple form of balanced valve, because the steam pressure is exerted in all directions and does not therefore force the valve against the valve seat, and the weight of the valve is the only thing tending to wear it or its seat. Steam is generally admitted to the cylinder past the inside, or center, edge of the valve, and the exhaust is past the outside edges.

The aforementioned valves all control the steam admission by the same edge, also the cutoff at each end of the cylinder. Any change in the point of cutoff also changes the point of admission and will affect the point of compression.

The riding cutoff valve consists of a main valve which controls the steam admission, release and compression, and a cutoff or riding valve which controls the point of cutoff and which generally rides on the top of the main valve. The advantage of this type is that the cutoff may be varied without affecting the other events of the stroke. Gridiron valves are of the multi-ported type and are on a number of makes of engines. Because of their many ports the valves require but a small travel.

The Porter-Allen engine is much used in rolling mill practice. There are two steam valves and two exhaust valves; the former govern the admission and cutoff of steam and the latter the release and compression. The simple eccentric actuates a link that moves the steam

and exhaust valves. The link has a peculiar motion, being of a horizontal and vertical throw of the eccentric. The link is restrained from rising by a trunnion, and the horizontal throw of the eccentric draws off the lap of the valve, while the vertical throw puts the tips of the link alternately to and from the cylinder as the eccentric rises or falls in its revolution, the upward throw tipping it from the cylinder toward the shaft. The tipping of the link opens and closes the steam valve by rocking a reach rod through a steam rod and arm.

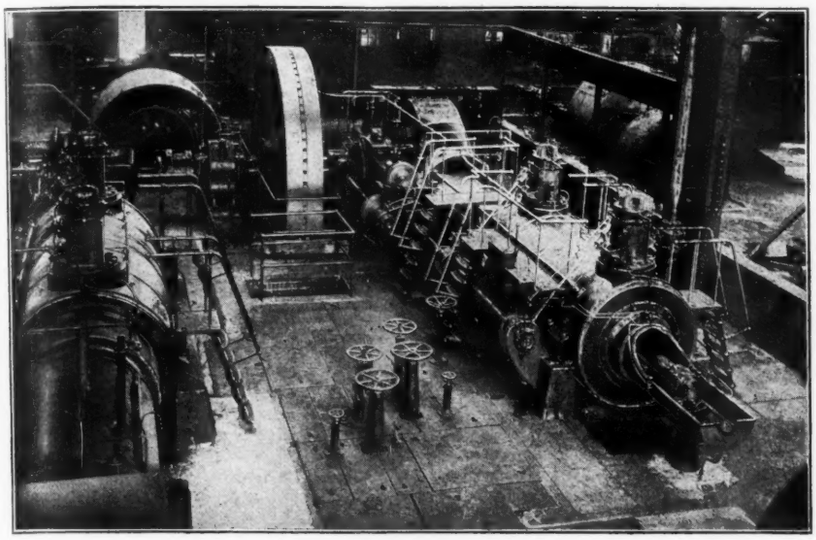


FIG. 2. UNIFLOW ENGINE USED TO DRIVE A 9- AND A 12-IN. MERCHANT MILL

The Corliss valve gear is composed of four semi-rotary valves, two steam and two exhausts, using both single and double eccentrics. The double-eccentric engine is mostly used in rolling-mill work when the Corliss type of engine is used. The single-eccentric engine will operate the cutoff automatically only up to one-half stroke, but a later cutoff is obtained by using two eccentrics and two wristplates, one set for the steam valve and the other for the exhaust valve.

Poppet-valve engines are used to some extent in this country. What is known as the Uniflow poppet engine uses but two valves, both controlling the steam admission to the cylinder. The exhaust is through a ring of exhaust ports that are cut in the middle of the cylinder casting and are uncovered by the piston at the end of the stroke, the piston therefore acting as an exhaust valve.

The engine cylinder and pistons are made longer than the usual practice in steam-engine design. Uniflow means that the steam flows in but one direction in passing through the cylinder. After cutoff the steam expands behind the piston, and at the end of expansion the piston uncovers the exhaust port for an instant and the expanded steam escapes. On the return stroke the steam at exhaust temperature and pressure is caught between the piston and the cylinder head, and as the piston moves back this steam is compressed, and as the compression is increased the temperature of the steam is increased.

It also absorbs heat from the heated head jacket, therefore the temperature of the steam in the clearance space is as high as and sometimes higher than the incoming steam at admission. Under this condition the steam at admission does not come in contact with cold surfaces and the initial condensation is required.

This type of engine is capable of carrying enormous overloads, such as are found in rolling-mill work, and also low underloads with a flat steam-consumption curve.

What are understood to be the two largest poppet-valve Uniflow engines in the country are used for rolling-mill service at the plant of The Youngstown Sheet & Tube Co. They are installed in an extension that was built about three years ago. The extension includes two mills, one being a 9-in. merchant mill and the other a 12-in. merchant mill. The engine driving the 9-in. mill is of 1,000 hp. capacity at 110 r.p.m., having a cylinder 37 x 48 in. The larger engine driving the 12-in. mill is 1,500 hp. capacity at 110 r.p.m. and has a 44 x 50-in. cylinder. Both engines operate condensing, exhausting into a barometric jet condenser.

Speed variation from 55 to 110 r.p.m. may be obtained on both engines, by proper adjustment of the governor drive. The engines are equipped with fly-ball inertia governors which control the cutoff of the steam valves. The governor is driven by a lay-shaft, Fig. 2, geared to the engine shaft. On this shaft is mounted a steel friction disc. A similar disc geared to the governor shaft is placed at a short distance from the former and in the same plane with it. Rotative motion is transmitted from one disc to the other by means of four fiber wheels which roll upon the discs. Two wheels rest on each disc, each wheel on one disc being connected by a shaft to the corresponding wheel on the other disc. The ratio between the distance of

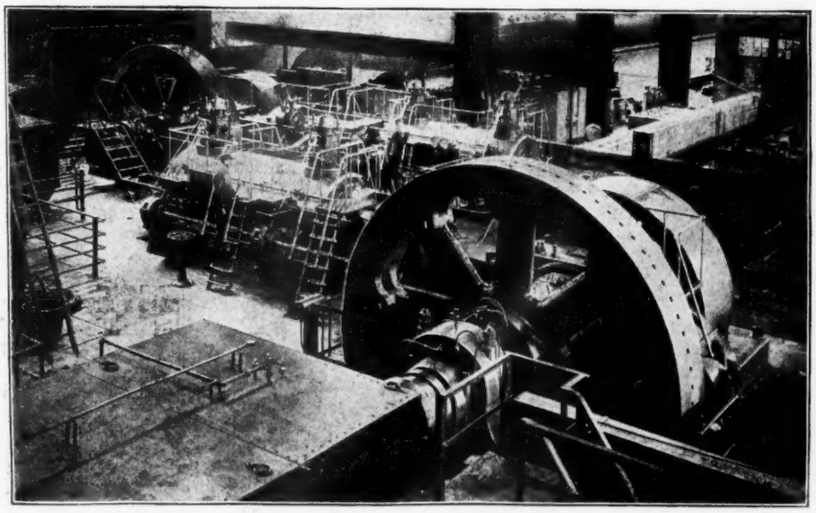


FIG. 3. NEAR VIEW OF ENGINE DRIVING 12-IN. MERCHANT MILL

the wheels from the disc centers determines the speed ratio between the engine and governor. This ratio may readily be changed by a movement of the floating frame on which the friction wheels are carried, an operation which may be accomplished while the engine is running. Inasmuch as the governor is designed to run at constant speed, or at least with no greater variation than 4 per cent, it is evident that a change in the position of the wheels on the discs will change the speed of the engine.

I was told that the governor was extremely sensitive, as it should be, and that the engine took the loads easily when the bar of steel entered the rolls of the first stand. After the bar passes through the first stand rolls, it enters successively the remaining five stands of the roughing rolls and the six finishing stands. This, of course, brings a suddenly increased load on the engine as the metal is reduced in each of the six roughing rolls. As soon as the last end of the bar has passed through the first roll, the load on the engine decreases and of course continues to do so until the bar has passed through the last finishing stand. It is seen that the governor must be very sensitive in order to maintain the engine speed at normal with its increasing and decreasing loads.

Some idea of the size of the mill may be gathered from the fact that the 9-in. mill is in a building 90 ft. wide by 1,150 ft. long, and that the 12-in. mill occupies a space 100 ft. wide by 1,200 ft. long. Both steam and motor drives are used with the 9-in. mill. The smaller of the uniflow engines drives the six roughing stands by means of beveled gear drives, and is so geared that the rolls of each stand run at an increased speed so as to take care of the increased length of the bar as it comes from the rolls preceding it. Fig. 1 shows the 9-in. merchant mill at the Struthers plant. In the background can be seen the Edward cooling bed, which is 400 ft. long.

A 700-hp. direct-current motor drives the first two finishing stands, and the other four are driven by two 500-hp. motors, two stands to each motor. A sizing mill is driven by a 100-hp. motor. The motors driving the 9-in. mill are housed in sheet-metal hoods to protect them from dirt and flying material, as shown beyond the engines in Fig. 2. The other motor is shown outside of the engine-room space. Each motor operates two stands of rolls by means of a belt drive, the motor pulley coming central between the roll pulleys, the latter being on the inside and the former facing on the outside of the belt, the bottom rim of the motor pulley coming down sufficiently below the top rims of the driven pulleys to insure an arc of contact sufficient to carry the load.

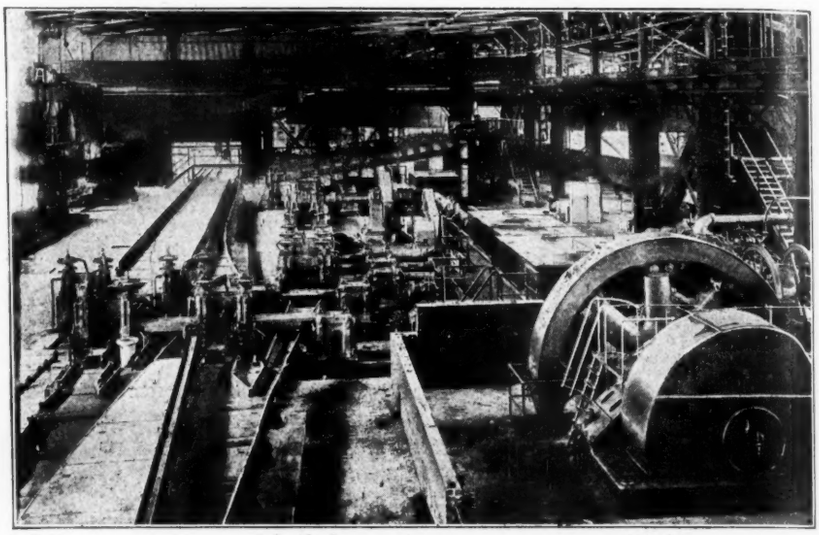


FIG. 5. ANOTHER VIEW OF THE 12-IN. MERCHANT MILL

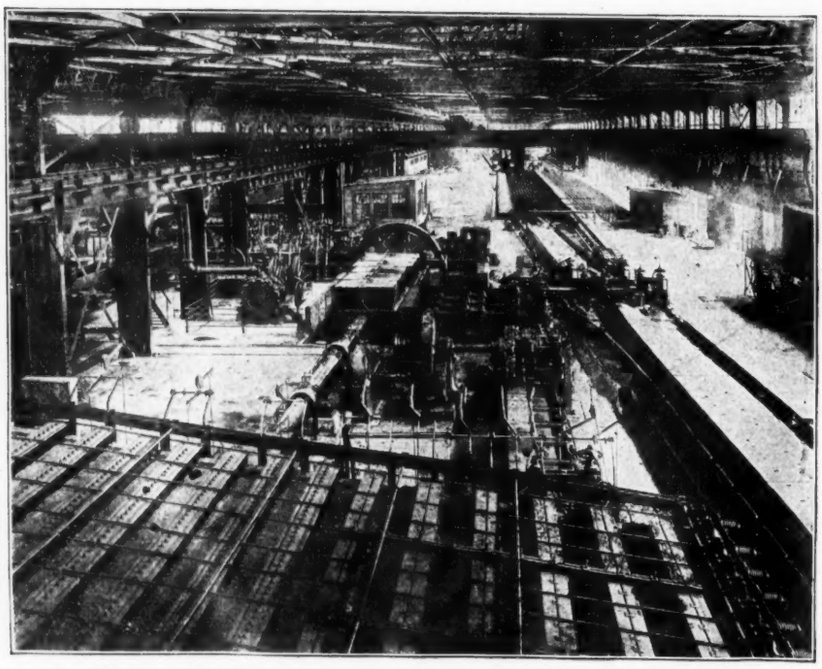


FIG. 4. THE 12-IN. MERCHANT MILL, SHOWING GEAR BOX AND AIR PUMP

The 12-in. mill is driven by the larger engine, Fig. 3. A general view of this mill is shown in Figs. 4, and 5. The engine and an air pump are shown in the center of the view. The crankshaft of the large engine is coupled to the gearshaft by a universal coupling, and a small, or breaking, shaft is placed between the engine and the gearshaft to prevent damage to the engine in case the rolls of the mill become clogged. If such should happen, the small breaking shaft gives way, and being of short length is easily renewed. The gear drives are inclosed in a gear box, Figs. 3 and 4, and the rolls of this mill are of different sizes and revolve at different speeds in order to take care of the lengthened bar in going through the roll. The conveyor rolls are operated by inclosed mill-type motors having a back-gear. All rolls have flexible couplings in which a coupling pin having four projections fits in corresponding sockets in the coupling head.

Both engines are equipped with safety stops, the system being provided with stations at various points in the mill, so that in case of accident the engine can be shut down from any of these points. All steam piping is placed below the flooring, and the steam pressure used is 155 lb., superheated 50 deg. As stated, the engine exhausts to a jet condenser that maintains a 25- to 26-in. vacuum. In summer the temperature of the water used reaches 130 deg. This is on account of so many plants using the water before it reaches this mill. In winter it is around 30 degrees and it is easier to maintain the vacuum.

In Fig. 6 is shown a general view of a 10-in. continuous skelp mill, composed of a roughing and finishing mill. The roughing mill is driven by a 26 and 48 x 48-in. cross-compound engine of 1,500-hp. capacity at 90 r.p.m. The finishing mill is driven by a 26½ and 48 x 48-in. cross-compound engine of 1,500 hp. at 100 r.p.m. This mill rolls skelp from 1⅝ to 7¾ in. in width. There are, it is understood, three other such mills in the United States, each producing from 10,000 to 14,000 tons of finished skelp per month.

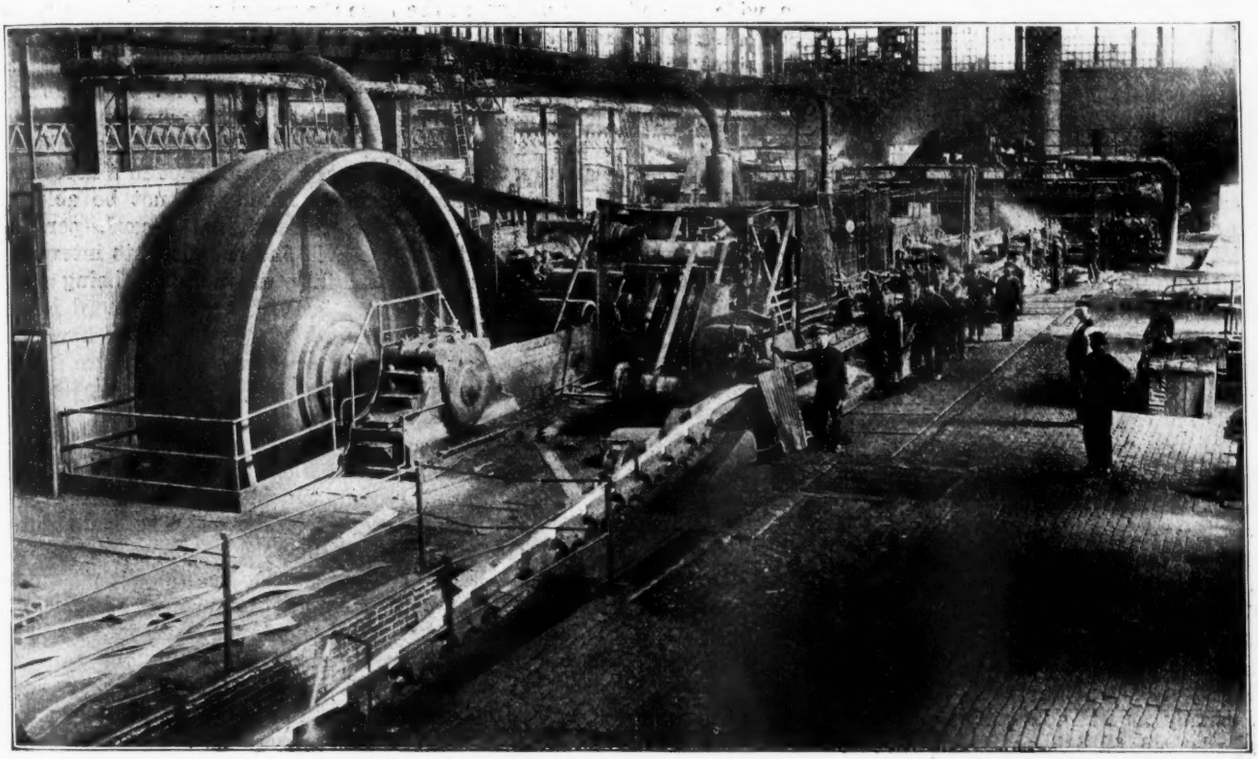


FIG. 6. A 1,500-HORSEPOWER ENGINE DRIVING A TEN-INCH CONTINUOUS SKELP MILL

(The next installment will take up some of the features of various types of rolling mills such as blooming, billets, plate, rod and sheet mills, all of which are of special interest.)

Surveys of the possible water power available in British Guiana indicate that on the Cuyuni River 285,000 hp. could be made available, on the Essequebo 475,000, and on the Demerara 38,000. It is estimated that power available for delivery within a two hundred mile radius would be about 156,000 hp. from the Cuyuni, 273,000 hp. from the Essequebo and 21,000 hp. from the Demerara. British Guiana is extremely rich in mineral resources, and the advent of electricity would open up immense sources of wealth.

Graphic Meter Records and Their Interpretation

By Walter L. Hamilton

To the uninitiated, records obtained from graphic meters are often as difficult to interpret as is the method by which they were obtained. To facilitate interpreting such records, a study of the meters producing them is useful.

Curve-drawing meters are used to record numerous conditions, such as temperature, pressure, flow of liquids and gases, speed, volts, amperes, power factor, kilowatts, etc. The benefits derived from their use are quite numerous and varied. A permanent record covering the total period of test is obtained of certain conditions, which permits discussion or study of working methods at times other than those at which the records were obtained. It is an interesting fact that a person is always interested in and will believe what is shown in picture form, when a mass of data obtained from indicating meters, covering similar conditions, is often considered too complicated to bother with.

In selecting curve-drawing meters for a given installation, the character of the service to be recorded and the results desired should be carefully considered. Like people, certain meters are best adapted to certain classes of work. You would not engage an engineer to wire a door bell, nor would it be desirable to install high-grade meters for unimportant work. However, if the meter is to be installed temporarily for study purposes, only the best high-grade apparatus should be used.

A record chart may be circular in form, a complete revolution of the paper representing a period of time, usually from twelve hours to one week. It may be oblong in shape and placed on the surface of a cylinder, its total length representing a definite period of time.

It may be of the continuous-strip type with one inch of length representing one hour or fraction of an hour. The continuous charts are almost always found in high-grade, high-priced meters, as a more powerful clock and a more complicated paper-feeding mechanism are required than in meters using circular charts.

Meters may be graduated to represent only a portion of their capacities, such as volt and frequency meters which are graduated from perhaps 60 to 100 per cent of capacity. This arrangement permits of a wider scale over the probable variation of the service to be recorded. They may be graduated from 0 to 100 per cent of capacity. Wattmeters and flowmeters employ this latter form of scale.

Certain meters will try to record accurately every variation in the load. This often gives a wide curve and, for fluctuating loads, is not altogether desirable. Other meters may be damped to such an extent that their records may represent more nearly average conditions, since a record of momentary peaks is not usually desired.

Oftentimes erroneous opinions of conditions are obtained owing to the time lag of the curve-drawing meter. In making special tests with portable curve-drawing meters, it is desirable to note for each test the time required for the pen to travel across the chart without load on the meter. This may be done by pushing the pen over against the top of the record, and with a stop watch note the time the pen requires to reach the bottom of the chart, or it may be determined by noting the advance in paper during the return travel of the pen, provided a high-speed paper feed is used.

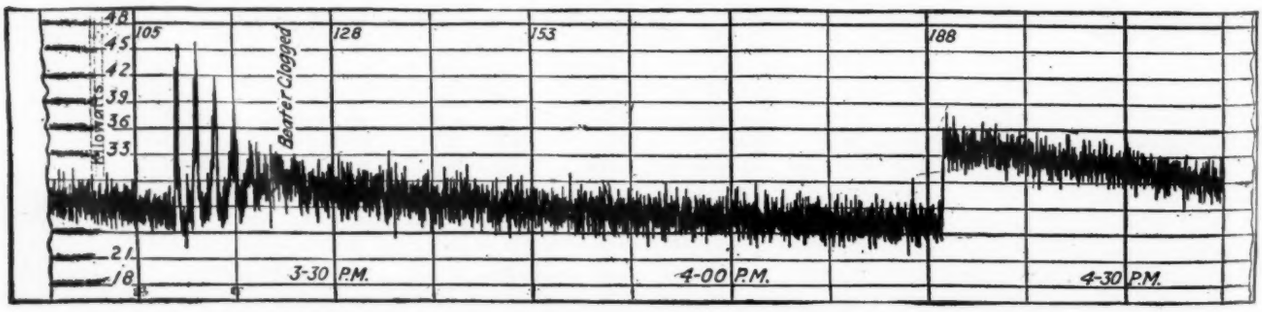
When curve-drawing meters are to be permanently installed, the paper feed should be as slow as possible as the problem of filing away their records is often found annoying. The circular chart should be small in diameter for the same reason. The clock forms a very important part of the meter, as the records would be of little value if the clock failed to keep proper time.

In the majority of industrial applications circular chart meters will be found very satisfactory, as there is usually an attendant constantly available to change records and fill ink pens periodically. In substations or transformer vaults of important installations the continuous-record meter with re-roll attachment is desirable, as the meter may be required to operate several days without attention.

The greatest value of curve-drawing meters appears in their use when arranged for portable work, and for research purposes under the supervision of a competent engineer. When they are to be used a short period of time to obtain engineering data or to investigate operating conditions, the continuous-chart meter should be provided, using sufficient paper speed to prevent the recording pen traveling more than twice over any portion of the chart. Oftentimes, when slow paper feed is used, the repeated travel of the pen over the same portion of the chart causes ink blots and unintelligible records. For this service every precaution should be taken while obtaining records, which will facilitate explaining them to persons unfamiliar with meter records. Meters using charts having rectangular co-ordinates and straight-line pen movements are best suited for this sort of work.

When making special tests, it is not only necessary to have high-grade apparatus, but the persons making the test should be careful observers of operating conditions and the equipment being tested, as an explanation of certain parts of the record would be difficult to obtain later unless, at the time the record was made, the cause for each variation in the curve was determined. No data should be left to memory while making tests. Too often, valuable tests are obtained, but owing to the lack of sufficient explanation they become practically useless after a short period of time. Data should be placed on the original record and not kept in a notebook, for after a short time the mind will not be able to connect the data with the original record, persons unfamiliar with the test will find it difficult to interpret, and there is the possibility of the data being lost. The accompanying chart is from a meter record taken by the writer during a test, and illustrates how the events of operation should be noted on the record itself. The curve was obtained by using a wattmeter of the straight-line type and represents the load on a 50-hp., three-phase, 60-cycle, 550-volt motor driving a beater in a paper mill by means of a silent chain drive. Owing to the length of this record, which covers a period of 24 hours, only a short section is shown. The meter producing this curve was a 100-volt, 5-ampere, polyphase instrument, and for this test 600- to 100-volt potential and 50- to 5-ampere current transformers were used. In obtaining curves, care should be used in selecting the proper size current transformers for the test in order that the curve will be well up on the chart and yet not go off the chart at any time, as variations in the load will be recorded with greater accuracy.

A point of considerable value, in interpreting this test, lies in the fact that the time markings read from left to right instead of from right to left as is the usual practice. All data connected with the test are lettered on the record at various points, and in addition to the curve-drawing meter, a watt-hour meter, an indicating voltmeter and an indicating ammeter were used. Paper without time or capacity markings was used, and the meter pen was arranged to use Higgins' black drawing ink. This permits making blueprints from the original charts.



SAMPLE RECORD FROM AN INDICATING WATTMETER USED DURING A TEST

Steam-Engine Operation and Maintenance — Loose Crankpins and Loose Cranks

By H. HAMKENS
Consulting Engineer, Newton, New Jersey

OCCASIONALLY we hear the word "foolproof" mentioned in connection with engines. It leaves the impression that engineers are liable to commit some foolish acts or that in an unguarded moment somebody may do a stunt with the engine, on which neither the manufacturers nor the owners or engineer have figured. The expression is a catchword, offensive in the highest degree. Its meaning is evidently that all the parts are protected in such a way that nobody, not thoroughly acquainted with the design, can make any change which would be detrimental and put the engine out of commission; it being understood, of course, that a man who knows what he is doing will not fool with any of the engine parts or their action. Fools have no business to be in charge of or working near an engine, whether or not it is protected against their thoughtless acts. No matter how well an engine may be constructed or how carefully all its moving parts are protected and lubricated, it should always be under the care of an intelligent attendant who has his eyes and ears open all the time and is prepared for an emergency.

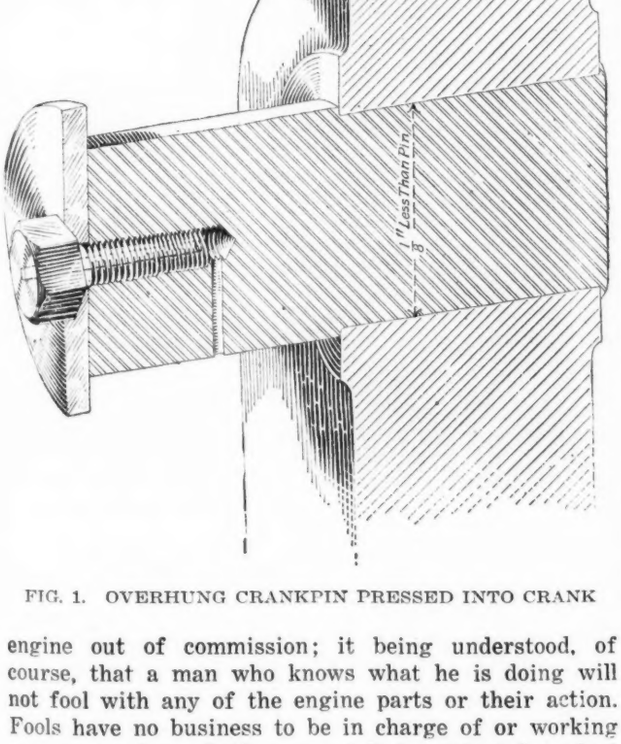


FIG. 1. OVERHUNG CRANKPIN PRESSED INTO CRANK

This thing of sending the engineer uptown to get some belt lacing or to the fourth floor to fix an elevator and in the meantime let the engine take care of itself is foolhardy to the thinking mechanic. The sooner it is stopped the less we shall hear about runaway engines and flywheel accidents. There are, of course, many so-called engineers in charge of power plants, who have not the slightest idea how a piston is constructed or what a valve looks like. All they know is how to turn on and shut off the steam and keep the oil cups and lubricator filled; of load conditions they are ignorant, have never seen an indicator, and do not know how to make adjustments on bearings, boxes or crossheads. This unfortunate condition is the cause of a great deal of trouble in engine rooms. Many a time a good-sized repair job could be prevented by a timely adjustment during the noon hour or after shutting down in the evening, if the man in charge of the engine had a thorough knowledge of its details.

Lack of instruction and inexperience of the man in charge of an engine are some of the causes of operating troubles for which the owner or superintendent of the place may be responsible by hiring an incompetent man. Our Government, state authorities, municipalities and large manufacturing concerns require drawings and specifications of every engine that they buy and install; but where is there a power plant, equipped with a one or two hundred horsepower engine which has on file a single drawing or print of the engine and its parts? In case of trouble, if the engineer is not familiar with the construction, an expert or a mechanic from the builders has to be called in, causing delay and expense. This can in many instances be avoided by insisting on having a set of detail drawings furnished with the engine when contracted for or installed.

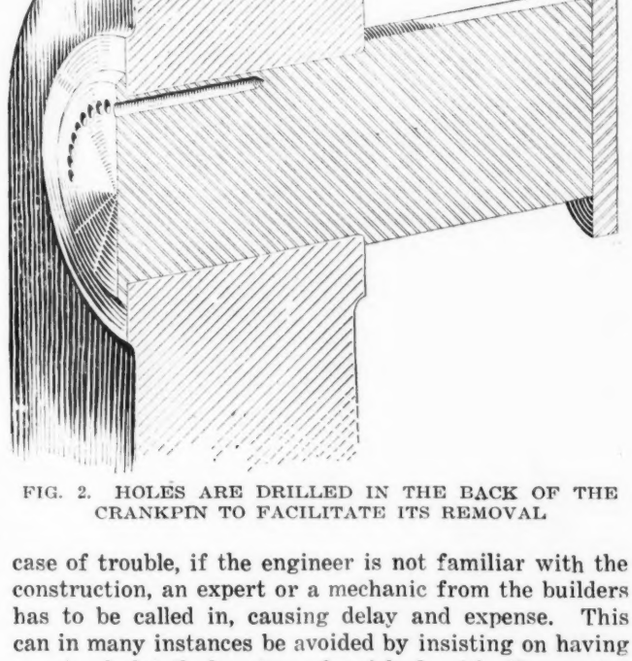


FIG. 2. HOLES ARE DRILLED IN THE BACK OF THE CRANKPIN TO FACILITATE ITS REMOVAL

Thirty years ago flywheel accidents were almost unknown. They began to happen soon after the introduction of electric power for street railways, when engine speeds were increased and the engines driven to the limit. From that time on operating troubles multiplied. Before we entered the electrical era a Corliss engine running 60 or 70 r.p.m. was after 20 years' service almost as good as the day it was started. Later on, with engines of that particular kind running from 100 to as high as 150 r.p.m., accidents and troubles have been the order of the day.

Some of the main operating troubles are due to the

violent changes of load to which almost all electrical installations are subjected. Belt or rope power transmission is easy on an engine compared with electrical service, for the reason that on the former the engine always carries a considerable friction load, which may be as high as 50 per cent of full load, while on a direct-connected engine the friction load rarely exceeds 10 per

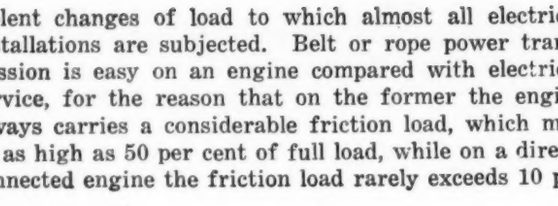


FIG. 3. THE CRANKPIN BORE MAY BE EXPANDED TO RECEIVE THE CRANKPIN BY HEATING IT WITH A HOT BAR

cent, and the change from full load to no load may take place almost instantly and at short intervals. Sudden changes of the load are hard on any engine and especially on those with releasing valve gears.

Great fluctuations of the load expose an engine to severe strains. They may be the cause at times of considerable pounding, which is hard to stop or even locate. An engine may run smoothly for a while, then all at once a change of the load starts a pound or a rattle of the valve gear, which is likely to annoy the engineer. Some engines have a chronic pound that is never located until by chance the cause is discovered where never suspected.

A heavy strain on an engine may be responsible for loosening the crankpin, causing at first a slight knock

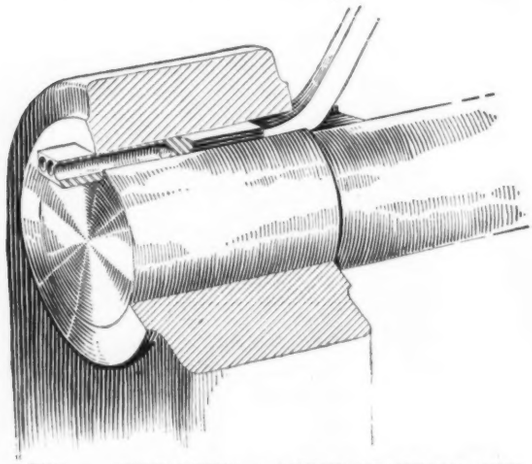


FIG. 4. REPLACING A LOOSE CRANKPIN KEY

which disappears with a lighter load, but gradually the pound increases and appears at more frequent intervals. In most engines with overhanging cranks the crankpin is forced into the crank and riveted over at the back, as shown in Fig. 1. The common practice is to make the pin in the hole ⅛ in. smaller than the overhung part and to allow from 0.001 in. to 0.003 in. per inch of diameter for a press fit. The accompanying table gives the average allowance for press fits of steel shaft or pin in cast-iron cranks.

Diameter of Shaft, or Pin, In.	Total Allowance per In. of Diameter	Allowance per In. in Diameter	Average Pressure Required in Tons
4	0.012	0.003	50
5	0.012	0.0024	60
6	0.012	0.002	75
7	0.012	0.0017	85
8	0.012	0.0015	100
9	0.012	0.00135	110
10	0.013	0.0013	125
11	0.013	0.0012	135
12	0.013	0.0011	150
13	0.013	0.001	160
14	0.014	0.001	175
15	0.015	0.001	185

For steel cranks the allowance is about one-half that for cast iron. To insure a good job, the pin as well as the hole should taper about 0.010 in. per inch of length. This is often neglected and may become the cause of a loose pin; in most cases the pin is tapered and the hole straight. Neither pin nor hole is truly round, since they are turned and bored respectively but not ground to

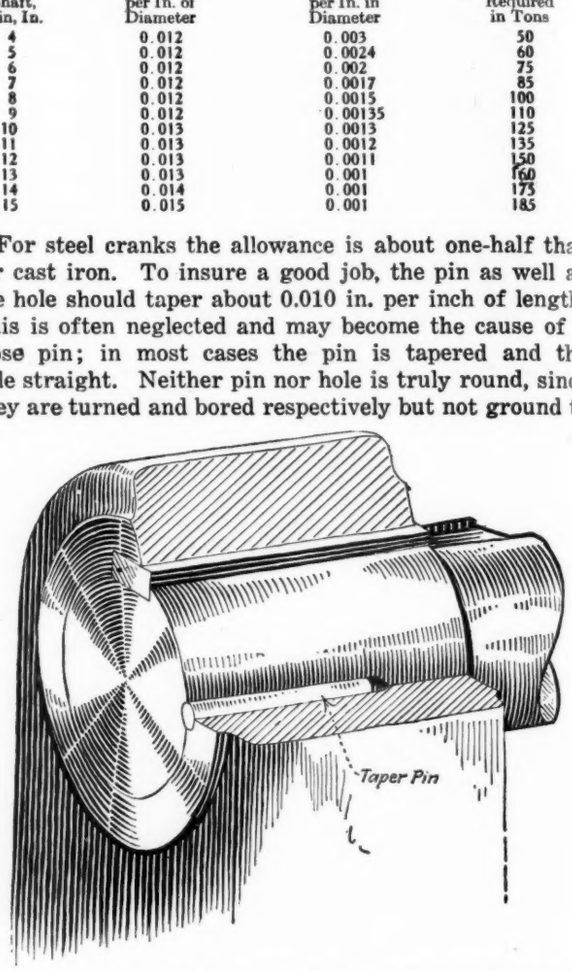


FIG. 5. A LOOSE CRANK MADE TIGHT BY DRIVING IN A TAPERED PIN

size. Either one of them or both may be out of round two or three thousandths of an inch. That may be one reason for a crankpin getting loose. Another may be that the pin does not enter the hole in a truly straight line. If not, it is liable to catch on one side and cut the metal, leaving a groove that will prevent the pin from getting tight. A mixture of white lead and linseed oil spread over the pin before pressing it in will prevent cutting. The riveting over of the end of the pin adds little to its tightness, if it was properly pressed in under a pressure approximating those given in the table.

There is no remedy for a loose crankpin except to have it removed and replaced by a new one. To remove it, a number of holes are generally drilled from the back about halfway through, as shown in Fig. 2, which, as a rule, will loosen the pin sufficiently to allow it to be driven out. It is not advisable to press it out as this is likely to damage the hole. Seldom is it desirable to rebore the hole. Previous to the time when hydraulic presses came into use, crankpins were shrunk in, and this method can be used with success if no press is at hand. For a shrink fit the practice is to make the pin 0.002 in. larger per inch of diameter than the hole.

The hole is expanded by the application of heat, either over a fire or by inserting a red-hot piece of iron into the hole, as shown in Fig. 3. The hole must be calipered from time to time, and when it is expanded sufficiently the pin is slipped in. This method requires some skill and good judgment; there is danger of having the pin stick if the hole is not sufficiently expanded, therefore no chances should be taken. Experience seems to show that a pin, if shrunk in right, will stay tight as long as the crank lasts.

Worse than a loose crankpin is to have the crank itself come loose on the shaft. The first expedient will be to remove the key and put in a new one, which may tighten the crank. The old key may be driven out from the back, but if that will not do, holes should be drilled into it as shown in Fig. 4, which will loosen the key sufficiently to make it come out by driving. To make a new key, a bar of steel is forged to the shape of the old key with an all-round allowance for finishing of $\frac{1}{16}$ in. to $\frac{1}{8}$ in., according to size. One end of the bar is bent double, as shown in the sketch, and the other is machined and fitted into the keyway by driving it repeatedly in and out and removing sufficient metal until it fits for about one-third of its length. It is then cut off about an inch longer than the depth of the keyway, covered with white lead and driven home. If the key has been made a good fit top and bottom and on the sides, it may tighten the crank again. To get a good driving fit on the sides, the key may be made in two pieces, as shown in the detail of Fig. 4. The two sides of the key that fit together have a taper of $\frac{1}{8}$ in. per foot; this kind of key, if well fitted and driven home, will stay "put." If the crank can be saved at all, it will do the work.

Another method to fasten a loose crank is shown in Fig. 5. It consists in drilling a hole halfway into the shaft and crank at 90 deg. from the key, reaming it out tapering to $\frac{1}{8}$ in. per foot and driving in a taper steel pin. The best material for this pin is tool steel. The diameter of the pin at the small end should be about one-eighth of the diameter of the shaft in the crank. Unless the crank is of steel or provided with a large hub, it is not safe to use the pin, as there is danger of splitting the crank.

(Mr. Hamken's next article deals with loose flywheels.)

On the Road with the Refrigeration Troubleman

By J. C. MORAN

An air-compressor intake sucks ammonia gas from a leaking flange near-by and seriously cuts down production in the shop where the air is used. In another plant, with both compressors running, there was no trouble; but with one machine operating ammonia disappeared from the receiver gage-glass. The installation of an ice tank in another plant caused loss of ammonia, beginning about noon. But at midnight it came back. The troubleman corrected all the faults—after finding them—and tells how.

WE HAD installed a 100-ton refrigerating plant in a vinegar factory and everything had been running nicely for about a month when the engineer called up and asked me to come out and help him locate an ammonia leak. But I was unable to find the leak on arrival.

Both the discharge and liquid lines ran through the machine shop, the condenser being on the roof of the shop. I tested the entire length of both lines with sulphur sticks and litmus paper a number of times, but failed to locate any definite point where the leak could be said to come from. Four times I made a trip out there to find the leak, with the same result. Of course, everyone around there was having a quiet laugh at my expense. The owners were vexed because the ammonia fumes interfered with work in the machine shop. Finally, headquarters told me to tear out the entire section of lines in the shop and put in new pipe. I was skeptical about whether this would help matters, but obeyed orders. When the new line was put in, the odor of ammonia was as strong as ever.

One of the men finally told me that there was no odor in the morning when they came to work, and sometimes not until well into the forenoon. With this as a clue I came on the job ahead of the men the next morning and found that the man was right. The ammonia compressor had been running all night. So the trouble was not in the line after all. It was 9:30 before I noticed any odor. Standing close to where one of the men started an air hammer, in a few moments I could smell ammonia.

It came to me with a flash that the ammonia smell was carried into the shop with the air used for the shop. Following this clue, I learned that the machine shop got its air from a large high-pressure compressor which also pumped a deep well, while the rest of the plant got air from a smaller low-pressure compressor. Now the only way in which ammonia fumes could get into the air would be from somewhere around the suction of the air compressor. So there I looked for the trouble. Sure enough, the suction line of the ammonia compressor had a flange connection a few inches above the intake of the air compressor and the former had sprung a "healthy" leak.

After pumping out the line and renewing the gasket in the flange, we tried again and this time it remained tight. Also, the leak in the machine shop disappeared. If I had known in the first place that the shop was getting its air from a separate compressor, I might have detected it sooner because I had given this consideration once before, but the rest of the plant showed no signs of it, and there were many other places where they were using air. You cannot take anything for granted when you are in trouble.

Some time ago I was called in by a friend to help him find what was wrong with his plant. He had two 50-ton machines and a single condenser. He was a great believer in condenser surface of liberal proportions so he had ample condenser capacity for 125 tons. The condenser used was of the ordinary atmospheric type. With both machines running he had no trouble, but

when he shut down either one the ammonia would disappear from the gage glass of the liquid receiver in a short time. At first the condenser pressure would drop, but gradually it would build up again until it was within a few pounds of the pressure carried when both machines were in operation. This happened every time one of the machines was shut down, and the engineer could find no reason for it. At first I was no more successful than he in finding anything that looked like trouble. Finally, after one of the machines had been shut down for a couple of hours and the ammonia had disappeared from the gage glass and the head pressure had first dropped and again gone up to nearly normal, I went up on the roof to have a look at the condenser. Putting my hands on it to check each coil to see if it was working at the proper temperature, I was surprised to find that about half of the coils were cold, or, as the average operating man puts it, "dead." If a condenser coil is working properly it will be warm at the top where the gas enters and for a few pipes down, while if it it is not working properly it will cool off to the same temperature as the water in a short length, and thus it becomes a simple matter to detect a coil that is not working.

Trouble Always in Four Coils

I had an idea that it was probably due to too much air in the system. So I thoroughly purged each of the dead coils. This helped matters, but I had to repeat the performance several times to keep the coils working. No matter what we would do, four out of the twelve stands refused to work continuously, and the queer part of it was that it was not always the same four that quit, but they were always close together and at some distance from the point where the discharge line connected to the header. The discharge for one machine connected to the header near one end and the discharge for the opposite machine near the other end. It was generally the coils in the center that made the trouble. If the trouble was near the ends, it was always at the end farthest from the point where the machine in operation was discharging its gas.

We came to the conclusion that the trouble could be due only to greatly different velocities in various parts of the gas header, and that this had the effect of practically bypassing some of the stands as the gas rushed by, somewhat on the same principle as a long distributing trough when the water is fed in at one end or near it. Most of the water will spill over near where the feed comes in, owing to the inertia of the water and the velocity of the flow.

Working on this theory, I began to choke off on the gas valves on those stands that were hottest. After a couple of days' experimenting I found that six of the coils could be run wide open, two nearly shut and four partly throttled. If we changed machines, we had to change the setting on some of the other coils or get in trouble again. Once having found the proper setting, however, it was no trouble to adjust the valves properly. We shut off the valve and then opened it the required number of turns or fractions of a turn, as previously determined by experiment. A record of the amount of opening of each valve for each machine in operation was hung in the engine room to guide the operator.

In this manner we were able to keep all the coils working at about the same temperatures, the condenser pressure remained low and the ammonia remained in the receiver. Previously, the ammonia had hung up in the dead coils in the condenser and refused to come down, owing to the sluggish action of these coils. I had seen similar cases before.

The owners of a packing-house plant had to buy considerable ice for icing cars and other purposes, and they decided to add an ice tank to their refrigerating equipment. They had plenty of machine capacity for this.

After the tank was put in operation, they had trouble from the start. Every day about noon the ammonia would begin to disappear from the receiver and would be gone entirely in the middle of the afternoon or toward evening. It would not come back until some time around midnight or later. Several times they had been troubled with heavy slugs of liquid coming back with the suction gas, causing thumps in the compressors which jarred the engine room. No one could account for them. They all blamed it on the ice tank, but just how it was to blame no one could explain.

I was sent out to solve the puzzle after the purchaser had refused to pay for the tank unless the trouble was remedied. Arriving about noon, I had been in the plant about fifteen minutes when the compressors made a series of thumps that jarred the floor. Something was wrong. On investigating the plant everything seemed to be in proper order. The next day I came on the job in the morning, and toward noon the ammonia began to disappear.

Suction Pressure Up

I insisted on attending to the handling of the expansion valves throughout the day, and this led to the detection of the trouble. Generally, in adjusting the valves in rooms where the temperatures are above freezing, I go largely by the appearance of the frost on the suction stop valve in each coil. A gang of men came up on the ice tank and began pulling ice between 9 and 10 a.m. In an hour or two they pulled enough ice to last for the day and proceeded to fill the empty cans with a rush with fresh water. Of course the brine temperature took a rapid jump and I increased the opening of the expansion valves. About this time the coolers began to load with fresh meat from the killing floor, and I opened up on the valves all around, except in the freezers, to hold the temperatures down as much as possible. When I got back to the engine room, the suction pressure had gone up eight pounds.

In about half an hour I went back to the tank and coolers and found that the suction stop valves, and in many cases part of the coils, were entirely free of frost. So I opened the expansion valves on these coils still more to bring the frost line where I knew from experience it ought to be for best results. When I got back to the engine room, the machines were running ice cold, and every once in a while there was a gentle thud in the cylinders, indicating that there was considerable liquid coming back in the suction gas. The suction pressure had gone up another two or three pounds.

I made a hurried trip to the coolers and ice tank again to locate the coil or coils from which the trouble was coming, but was surprised to find that none of the suction valves on the coils or on the ice tank was still frosted, except one or two which were frosted slightly at the flange where they connected to the pipe. From past experience I was almost certain that the trouble was not coming from any of these coils, unless there was brine or water in the ammonia.

The only valves untouched so far that morning were those on the three freezer coils. There were six expansion valves and coils in the three freezers, and to make a sure test on these I shut them all off tight and hurried back to the engine room.

It was a short time before the machines began to warm up, while the suction pressure remained practically the same. Soon the frost began to come off the suction connections of the machines, while the discharge began to get very hot, indicating that the suction gas was coming back superheated. The engineer and oilers were now cursing the new tank louder than ever and blaming it for the new trouble which kept them busy at the stuffing boxes.

Another hurried trip to the coolers was made and the expansion valves on the ice tank and coolers opened still more. I remained until they began to show signs of frosting to the nuts on the stuffing boxes. When I got back to the engine room the suction pressure had taken a still further pump, but the machines were cooling off and some of the ammonia was coming back into the liquid receiver gage glass.

After a couple more trips to the coolers and the tank, I finally got the expansion valves so adjusted that the frost lines on the suction stop valves on nearly every coil were up over the stuffing-box packing nuts, and on one or two up on the stems of the valves, at which points the machines worked at about the proper temperature and the frost line carried back to about the right point on the machines. The suction pressure was now about 30 lb., whereas in the morning it had been below 15 pounds.

The plant had a liberal amount of piping in every room and also in the tank. With proper attention to the expansion valves it was possible to follow the changing temperatures in the coolers and tank and not the suction pressure. However, when the suction pressure went up the freezers were practically put out of commission because the temperature in these was so low that with a high suction pressure there would be no temperature difference between the ammonia in the coils and the air on the outside of them, and the ammonia simply accumulated in the coils until it overflowed into the suction line. Every time the doors to the freezers were opened and a current of warm air struck the coils, the ammonia in the coils would boil up for an instant and throw heavy slugs into the suction line. It was a surprise to me that they did not have more serious trouble than they had been having.

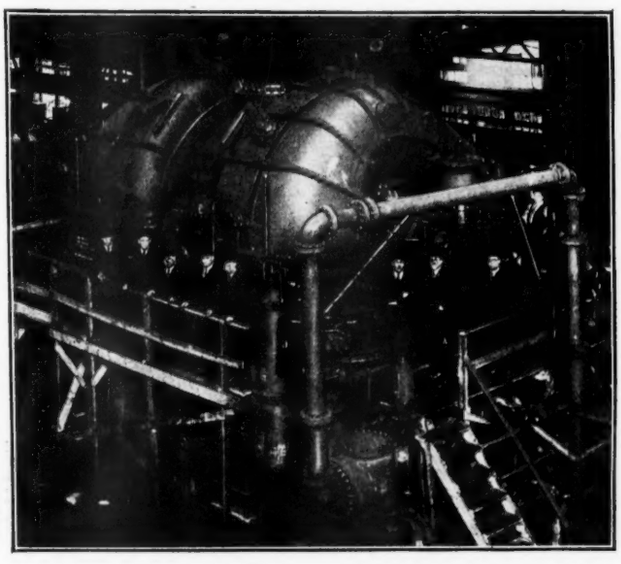
They had got along without trouble before the ice tank was installed because they had not worked the coils in the meat coolers to full capacity, opening the expansion valves only enough to do the work during the day's run and leaving part of the coils thawed off. This directed a lot of superheated suction gas into the suction line, and when this mixed with the liquid coming from the freezer coils it about balanced, and the gas going to the machines was about right. So no trouble was experienced in keeping the machines at the proper temperature. With plenty of machine and coil capacity it was no trouble to operate, but it was not economical.

When the ice tank was installed, it threw an additional large amount of gas into the suction line and the suction pressure went up so high that it became necessary to work the cooler coils harder, with the result that there was less superheated gas going into the suction line, and with the higher suction pressure less ammonia was evaporated in the freezer coils and more thrown into the suction line. The trouble was further increased by the manner in which the ice was pulled from the tank. The entire amount being pulled in a short time and at the time of day when the load was being put into the coolers tended to send the suction pressure far above normal during part of the day, putting the freezers entirely out of operation as far as evaporating ammonia was concerned.

The remedy was simple. First, we arranged to have a man come on duty at 11 p.m. and work till 7 a.m., and pull steady all night on the ice tank in addition to looking after the temperatures of some of the coolers. The regular gang then came on at 7 a.m. and pulled whatever was necessary in a short time. Nothing more was done on the tank until toward midnight. This kept the load fairly uniform all over the 24 hours, although there was still quite a jump in temperature in the afternoon. To make the system still more flexible and enable it to work to the best advantage at all times, we changed the suction connections to some of the rooms so as to put the storage coolers and freezers on a separate line, and arranged it so that we could use any one of the machines on it independently. When the suction pressure got too high on the main system for the freezer coils to work properly, we cut the system in two and carried a lower pressure on the freezers and storage coolers, thus pulling their temperatures down, while the suction pressure on the main system was allowed to go as high as it wanted to. As a result of the change the engineer claimed that he made a saving of over 25 tons of coal per month.

Steam-Turbine Has Record Run

A Westinghouse turbine generator at the power plant of the Narragansett Electric Lighting Co., Providence, R. I., recently established a world's record by running continuously without a shutdown for a period of 84 days, 11 hours and 36 minutes. The unit is a multiple-element steam turbine of the cross-compound type with a capacity of 45,000 kw. During this run 85 per cent of the total station output was generated by this unit. The record was made with a load varying from a minimum of 6,000 kw. to a maximum of 41,000 kw.



Operating Two Similar Alternators Having Opposite Polarity in Parallel

An Alternator Operating in Parallel with Other Machines Will, if the Polarity of Its Field Poles Is Reversed, Slip One Pole and Still Operate in Parallel with the Other Machines, Without Any Change in Connection

BY B. A. BRIGGS

WHERE two or more alternators are operating in parallel, the question frequently arises, What would be the effect of reversing the polarity of one machine and then trying to connect it in parallel with the other machines? The question is easily answered by the use of a diagram representing the alternators with ring armatures. In Fig. 1 is represented two three-phase alternators connected in parallel to a busbar; each alternator's field poles are excited the same polarity. With the armatures rotating in the same direction, indicated by the curved arrows, there will be a voltage generated in the winding of a polarity indicated by the arrowheads which, at the instant shown in the figure, will tend to cause a current to flow from terminal *A* of both machines through the load and back in on terminals *B* and *C*. The active part of the armature winding in supplying current to the load is indicated by double arrowheads.

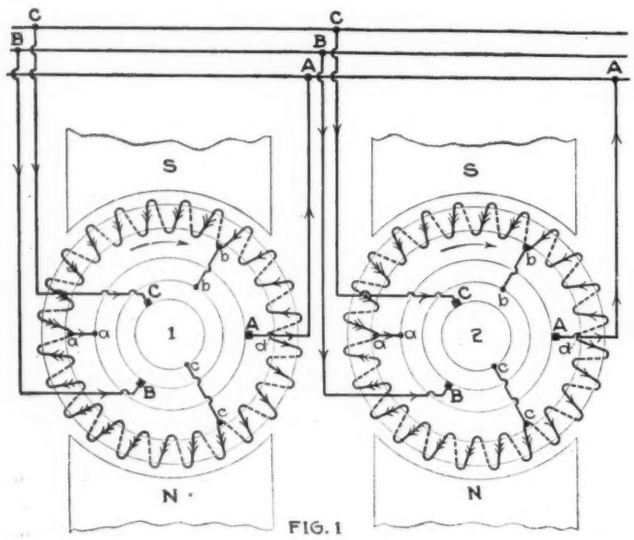


FIG. 1

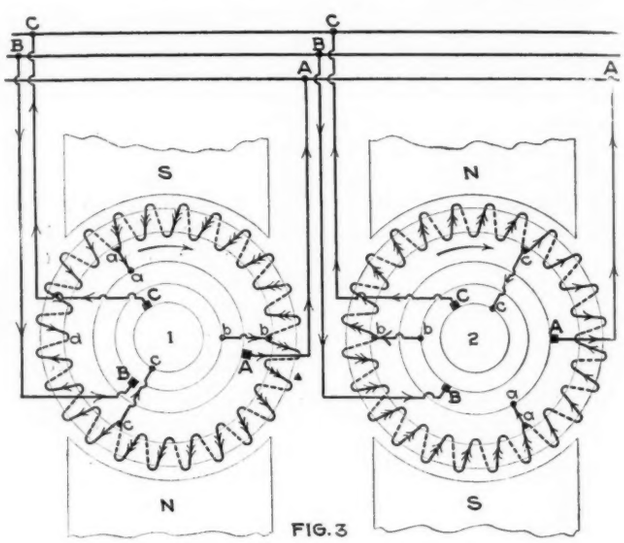


FIG. 3

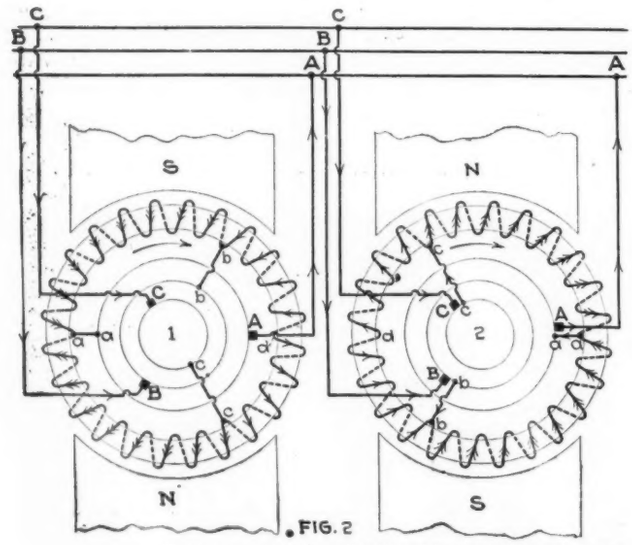


FIG. 2

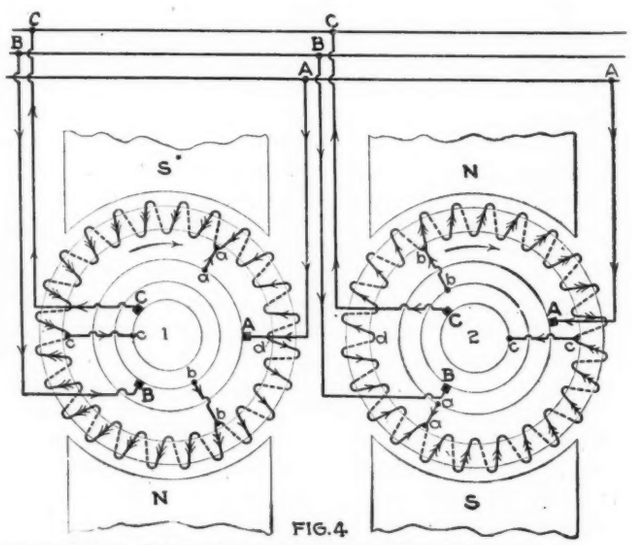


FIG. 4

FIGS. 1 TO 4. SCHEMATIC DIAGRAMS OF TWO ALTERNATORS OPERATING IN PARALLEL

In Fig. 1 the armature windings are represented by the letters *a*, *b*, *c*, *d*, and the field poles by *S* and *N*. The armature windings are connected to the busbar through the terminals *A*, *B*, *C*. At the instant under consideration the sections of the armature windings *bd* and *cd* are not effective in causing a current to flow to the external circuit, since the voltage in these two sections oppose. The armatures, being in exactly the same relative position, will be in absolute synchronism.

Now, suppose that the polarity of the field poles of machine 2 is reversed as in Fig. 2; the polarity of the armature will be reversed, and if the armature remains in the same relative position as in Fig. 1, terminal *A* will be negative and the machine will be out of step by 180 deg., with machine No. 1; or in other words, there will be a short circuit between the two machines with double normal voltage of one machine to cause a current to flow between them.

A study of Fig. 2 shows that the two machines are in synchronism as in Fig. 1, but to obtain this condition, the armature of No. 2 machine has turned through 180 deg. from the position in Fig. 1. This is what is called slipping a pole; that is, the armature has turned through an angle represented by the pole pitch, which in a two-pole machine is 180 deg., in a four-pole machine, 90 deg., and in a six-pole machine, 60 deg., etc. In all cases, however, the pole pitch is represented by 180 electrical degrees. The voltage applied to the circuit under consideration is that between *c* and *a* and *b* and *a*. As pointed out in the foregoing, the voltage generated in the section of the winding between *c* and *b* is not effective, since that generated in the section of the winding between *c* and *d* is equal and opposite to that generated in the section of the winding between *b* and *d*.

The next thing to consider is, will the armatures be in synchronism at other points in their revolution? To determine this, let us turn our attention to Figs. 3 and 4. Both machines are turning in the same direction, as indicated by the curved arrows. Assume that each armature turns 60 deg. from the position in Fig. 2. This will give the position Fig. 3. The direction of the arrows on the armature winding indicates that terminals *A* and *C* on each machine are positive and *B* negative and the machines are still in synchronism although the armatures occupy relative positions 180 deg. apart.

Again, assume that the armatures have turned another 60 deg. Then they will be in the position indicated in Fig. 4. A study of this figure shows terminal *C* to be positive and terminals *A* and *B* negative. Since each armature is in a position where the voltages generated in the section of each winding between *a* and *c* are equal, likewise in the section between *b* and *c*, the two machines are in exact synchronism. Therefore, as long as the two armatures continue to rotate at exactly the same speed, their voltage would be in synchronism.

From the foregoing it is evident that if two alternators are operated in parallel and have their field poles excited the same polarity, the armature will occupy the same relative position at exact synchronism. If the polarity of the field poles of one machine is reversed, the armature of this machine will slip one pole; that is, it will occupy a relative position 180 electrical degrees from the armature of the other machine, and the two machines can be operated in parallel as when the field poles of the two machines have the same polarity.

The only exception to this rule is where both machines are driven by the same source of motive power, such as two alternators geared to the same turbine. In this case, after the machines have been properly connected to operate in parallel, if for some reason the polarity of the exciting current is reversed through the field coils of one machine, the two machines would be 180 degrees out of phase and would have to remain this way since they are both geared together. In such a case the two machines would be inoperative until the polarity of one machine was changed. Where each machine is independently driven, the armatures can take any relative position to bring them into synchronism and the direction of the exciting current in the field coils makes no difference as to parallel operation of the machines. In the foregoing the armature has been referred to as the rotating element. In machines of the revolving-field type the statements regarding the relative position of the armature would also apply to the field poles. The next article will consider the effect of reversing the direction of rotation of an alternator that has been operating in parallel with other machines.

Preventing Sludging of Oil in Transformers

It is truly said that the life of its insulation is the life of the transformer, for when the insulation is gone the transformer is not only useless, it is dangerous. For this reason the efforts of transformer engineers have been directed to a considerable extent to developing methods of preserving the insulation for the longest period possible under all sorts of operating conditions.

The factor that has the greatest effect in reducing the dielectric strength of insulation is moisture. Therefore, the transformer was first protected by having its coils immersed in oil, so that no water could get to them. Later, as operating potentials increased, further protection was afforded by impregnating the fibrous insulation with a moisture-proof compound previous to its immersion in oil. Even then, owing to the high sensitivity of oil to water, the slightest water content, 18.5 parts per million, will reduce its dielectric strength to the lowest possible limit, and further measures were found necessary. With the increase of outdoor installations the expedient was devised of making the tank covers water-tight to further protect the insulation from water, snow, etc. This requires an expensive tank construction and also leaves an idle air space between the oil and the cover, which is necessary to provide for the expansion of the oil when heated.

The presence of this air space above the oil makes possible two other effects that are likely to cause trouble in operating and shorten the life of the transformer. One of these is explosions, and these are made possible by arcing or static discharges, or heavy overloads sometimes cause combustible gases to be set free from the oil, which, when combined with the air in the ordinary tank, form a highly explosive mixture. This gas may be ignited by sparks, either dynamic or static, causing a dangerous explosion. While the leads of some types of transformers are protected by ground shields that make this impossible under ordinary circumstances, still with the oil in the tank at an abnormally low level the effect of the ground shields may be neutralized.

The other feature that may have a deteriorating effect is what is known as the sludging of the oil. Any transformer oil will, when heated in the presence of oxygen, decompose, and a precipitate will be formed, consisting of carbons, etc. While this sludging has

no effect on the dielectric strength of the oil, the precipitate settles on the insulation, where it forms a film of low heat conductivity, so that the operating temperature increases, with a consequent increase in the sludging. The remedy for this state of affairs has been a periodical filtering of the oil, and cleaning of the coils and insulation of the transformer.

It has been found by a series of tests that oil will not sludge even under considerable and continuous operating temperatures, if it is kept completely free from any contact with air. The most that happens under these conditions is a slight discoloration of the oil.

To remedy these faults the General Electric Co. attaches to its transformer tanks a new device, known as an oil conservator, Fig. 1. This conservator consists simply of an auxiliary tank attached to the transformer tank so as to be well above the oil level in the main tank. Its only connection to the transformer tank is through a pipe, Fig. 2. When the conservator is supplied with oil, the main tank and the connecting pipe are also completely filled, so that the oil comes in contact with the air only in the conservator.

The conservator is just big enough so that all expansion and contraction of the oil take place within

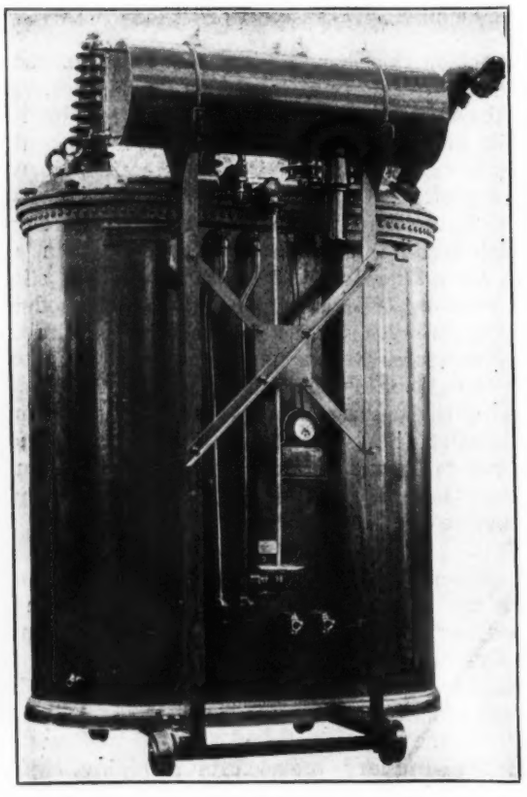


FIG. 1. HIGH-VOLTAGE TRANSFORMER WITH OIL CONSERVATOR

it, without lowering the level enough to bring the oil in the main tank in contact with the air or raising it enough to overflow the tank. Moisture absorbed by the oil is drained from a sump in the bottom, Fig. 2. The formation of explosive gas, with its consequent possibility of dangerous explosions, and the sludging of the oil when heated, are both eliminated, since the transformer main tank is completely filled with oil and can be made water and air tight. Since there is only one oil connection between the conservator and the main tank, and that is of limited size, there can be no circulation between the two, and the only change

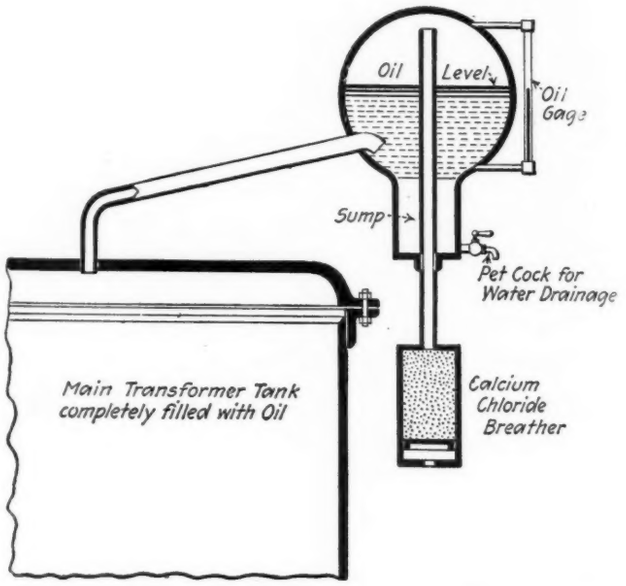


FIG. 2. ESSENTIAL FEATURES OF TRANSFORMER-OIL CONSERVATOR

in level is that due to the volume changes in the whole body of oil. Such being the case, hot oil cannot come in contact with the air, even in the conservator, and sludging will not take place.

Specifications for Lubricants

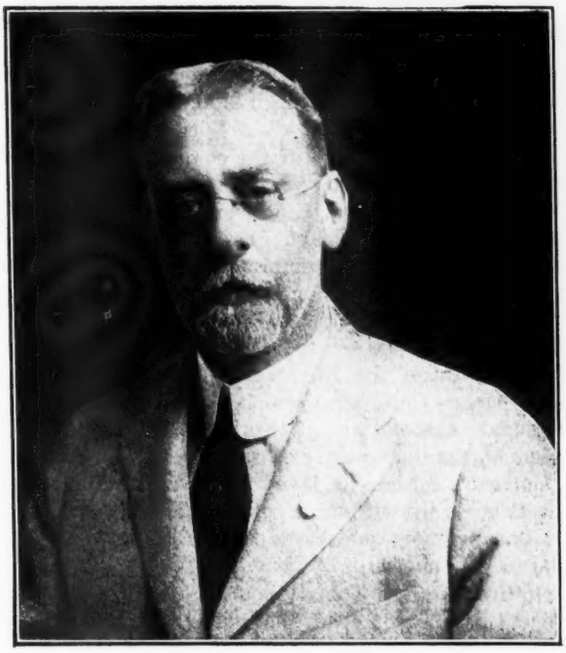
The following specifications for lubricants were prepared for the governing Board of State Institutions of by the faculties of the engineering departments of the Kansas State Agricultural College and the University of Kansas, Prof. A. A. Potter, chairman.

Kind of Oil	Viscosity in Seconds at 100° F.	Viscosity in Seconds at 210° F.	Flash Point Deg. F. (Minimum)	Pour Test Deg. F. (Maximum)	Carbon Residue % (Maximum)	Acidless Tallow %
1. Air compressor oil	240 to 300	45 to 50	400	15	1/32	0
2. Automobile oil, light	160 to 220	40 to 50	350	20	1/32	0
3. Automobile oil, medium	270 to 330	45 to 54	350	35	1/32	0
4. Automobile oil, heavy	340 to 420	50 to 65	375	45	1/16	0
5. Dynamo oil	140 to 200	38 to 45	370	25	..	0
6. Engine oil, high-speed	140 to 200	35 to 45	350	35	..	0
7. Engine oil, slow-speed	180 to 300	40 to 55	350	35	..	0
8. Ice-machine oil	130 to 205	.....	300	0	..	0
9. Steam-cylinder oil, dry steam	.....	135 to 165	450	50	..	5
10. Steam-cylinder oil, wet steam	.....	120 to 160	450	50	..	5 to 10
11. Steam-cylinder oil, superheated steam	.....	150 to 250	(a)	50	..	0
12. Truck or tractor oil, heavy	475 to 550	55 to 70	400	50	1/16	0
13. Tractor oil, extra heavy	1200 to 1600	90 to 125	450	50	1/16	0
14. Transmission-gear oil	.....	170 to 215	300	50	..	0
15. Turbine oil	140 to 240	38 to 45	370	25	..	0

(a) Depends upon steam temperature.

The largest hydro-electric plant in the world is being planned. It is to be located on the Priest Rapids site on the Columbia River, near the Oregon-Washington border. Its maximum capacity will be 700,000 hp. at high water and 400,000 hp. at low water. Plans are being delayed until Congress passes the water-power leasing bill, now held up in conference by Senate and House Committees.

Joseph Harrington
Combustion Engineer



One of the Leaders in the Middle West in the Economical Use of Fuel in the Power Plant

ALMOST everybody in the power-plant field in and about Chicago, in fact throughout the Central States, knows Joe Harrington, and his reputation as a combustion engineer has extended far beyond these confined limits. Burning coal efficiently, particularly the coals of the Middle West, has been his lifelong study. In the early days of his apprenticeship to this field the inferior grades of bituminous coal, such as slack or screenings, were actually discarded and considered unfit as power-plant fuel. To eliminate this economic waste the chain grate was designed. Mr. Harrington has been associated closely with the development of this type of stoker from its infancy and has been largely instrumental in showing that these inferior grades of coal could be burned efficiently. He is now developing a universal stoker designed to burn coals of all kinds with equal success.

Reverting back to his youth, Joseph Harrington hailed from New England, the home of his ancestors for five generations. One of these ancestors on his mother's side was General Montgomery, of Revolutionary fame. He was born at Reading, Mass., a suburb of Boston, in 1873, and being near the Bay he spent much of his early youth on the water. Like many other New England boys he was always interested in anything pertaining to mechanical pursuits. His father had a shop to which Joe and his brothers always had access. They were encouraged to play in this shop, and before the subject of this sketch was out of high school, he was a skillful machinist.

Graduating from the Massachusetts Institute of Technology in 1896, Mr. Harrington spent the next four years in Mexico and Central America, prospecting in the mining regions and surveying for railways and rubber-plantation interests. During his school life he had picked up a working knowledge of the transit. But his liking was for things mechanical, so after four years of roaming he settled in Chicago. He was employed by the Green Engineering Co. as chief engineer for the twelve years ending 1912. Along with the development of the stoker Mr. Harrington gave much attention to the furnace, the ignition arch and other appurtenances necessary for efficient combustion. During these twelve years he gained a wide acquaintance in power-plant circles and was generally acknowledged as a leader in his particular field.

It was his thought to capitalize on this reputation when at the end of 1912 he withdrew from his former connection to become an advisory engineer in the operations of power plants, in particular on questions relating to combustion. In this work he became intimately acquainted with all the details of operation. He saw the difficulties as viewed by the operator and came in touch with defects, mechanical and human, that could be gained only in this way.

Work of greater magnitude in the industrial field momentarily enticed Mr. Harrington from the power plant. He became interested in powdered coal and in particular its application to heating furnaces in rolling mills. Several installations that were highly successful are to be credited to his long list of achievements. Memories of his first love, however, eventually drew him back to the field of stoker design and manufacture. In 1917 he became engineer and vice president of the James A. Brady Foundry Co., Chicago.

Mr. Harrington found time to do his bit for the Government during the war. He was appointed by the United States Fuel Administration administrative engineer for Illinois, having charge of fuel conservation and supervision of power. With his thorough knowledge of fuel and its burning and his exceptional ability as an executive and organizer, Mr. Harrington soon had the work under way. The questionnaires from Washington were sent out, and through numerous volunteers the power plants of the state were rated and their deficiencies pointed out to the plant owners. Volunteer inspectors were sent out on the job, and service was rendered to those requesting it. The work was entirely educational and by suggestion rather than by arbitrary regulation. One of the original features of the Illinois campaign was a series of weekly letters dealing with the primary factors entering into economy and conservation. They were elementary and semi-technical in character and by local volunteer committees, were

printed and distributed to every plant in the state. Commendation came from all parts of the state and from Washington. Mr. Harrington was congratulated on his aggressive campaign and the excellent results that were being effected.

Among the engineers of the community Mr. Harrington has always been active. He belongs to the American Society of Mechanical Engineers, and at one time was chairman of the Chicago Section. He is active in a number of standing committees of the society and a contributor to the Boiler Test Code. Recently, he has been appointed chairman of the Committee on Smoke Prevention of the Western Society of Engineers. He is a member of the Engineers Club of New York, the Old Colony Club, and an honorary member of the National Association of Stationary Engineers. An excellent speaker who can talk from the shoulder at a moment's notice, he is in frequent demand. Scarcely a week goes by without a call on his time and requests for one or more addresses before engineering, industrial or commercial associations.

Nothwithstanding his popularity and the constant demand for his presence elsewhere, Mr. Harrington is a great lover of his home at Riverside. An acre of ground attached to it gives him an opportunity to get close to nature and work with the flowers and shrubs in his ample garden.

Novel Water-Pumping Motor

A novel method of pumping water has been developed by F. L. Gilman, of Los Angeles, Cal. The apparatus is anchored in the middle of a swiftly running river and in swaying back and forth operates two pistons of a pump located on the bank. The pistons have a 22-in.

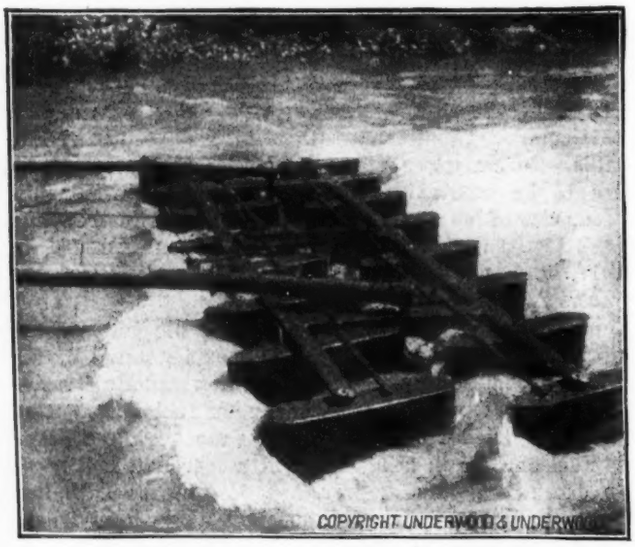


FIG. 1. FLOATS ANCHORED IN MIDSTREAM

stroke, and the pump has a capacity of 80 gal. of water per minute, discharging through a 3-in. pipe against a head of 18 feet.

The floats are anchored in the stream and are held in position by long anchor rods attached to a frame to which the several floats are so secured that they are free to change from one angle to an opposite angle. That is, as the floats, Fig. 1, move across the stream, and upon reaching a definite travel, the angle of the floats is changed and, owing to the velocity of the water impinging against them, the float head is moved across the stream in an opposite direction. Upon reaching a predetermined travel, the angle of the floats is again reversed and a return travel is made.

FIG. 2. GENERAL VIEW OF THE INSTALLATION

Connection is made between the float head and the pump on the bank, Fig. 2, by cables attached to a crosshead, located at the pump, to which the pump pistons are connected. As the float head moves back and forth, its motion is transmitted to the pump crosshead and in turn to the pump plunger.

Recommends Standard Shafting Sizes

A committee of the American Society of Mechanical Engineers formed to investigate the possibility of standardizing shafting sizes, in a recent report to the council recommended the approval and adoption of the following lists of sizes as standard for the society:

Transmission Shafting: $\frac{1}{2}$ in.; $1\frac{1}{16}$ in.; $1\frac{7}{16}$ in.; $1\frac{11}{16}$ in.; $1\frac{15}{16}$ in.; $2\frac{3}{16}$ in.; $2\frac{7}{16}$ in.; $2\frac{11}{16}$ in.; $3\frac{7}{16}$ in.; $3\frac{15}{16}$ in.; $4\frac{7}{16}$ in.; $4\frac{15}{16}$ in.; $5\frac{7}{16}$ in.; and $5\frac{15}{16}$ in.

Machinery Shafting: Size intervals extending to $2\frac{1}{2}$ in., by sixteenth inches; from $2\frac{1}{2}$ in. to 4 in. inclusive, by eighth inches; from 4 in. to 6 in., by quarter inches.

The adoption of these standard sizes will mean the reduction in the number of parts of power-transmission equipment that must be carried in stock, and the committee expressed the opinion that in the future a gradual elimination of odd sizes from makers' lists and from dealers' stocks would take place and the standard sizes would be used for all new construction.

The committee is planning to reorganize itself and add to its membership, so that the standardization of shafting formulas and the dimensions of shafting keys and keyways can be investigated.

Graduate students of the Massachusetts Institute of Technology are conducting experiments in the research department of the hydraulic laboratories on the design of draft tubes for water turbines, to gain increased efficiency.

EDITORIALS

A Needed Feature of the Refrigerating Industry

IN REFRIGERATION the war revealed things of great import no less than in other fields. In this art the United States has attained by far the greatest advance, and it is generally conceded, we believe, that had it not been for the well-located and well-managed large refrigerated warehouses, the Allies would have been badly off for foodstuffs. It was not only the large stock immediately available when the sudden call came, but the ability to take in huge shipments, chill and clear for transatlantic transport, that was invaluable. This was the period in which Europe was learning her lesson. As a result, it is reasonable to expect refrigeration to find a wide and rapid growth there.

The charge has been made that the development of this art, even in the United States, has not been so rapid or so spectacular as the possibilities permitted or as compared with developments in other branches of engineering and physics. The critic can make out a good case, but the day for making it rapidly passes by. Refrigeration is now having its new era, its period which is not unlike those experienced in the pure power field by the introduction of electricity and the steam turbine. The high-speed compressor daily demonstrates its remarkable potentialities. Continued improvement in central-station design, electrical apparatus and compressor valves insures the future of this type of machine.

But the compressor and its drive are but a part of the system, and a part that is essential only because of the physical properties of the refrigerant, ammonia. Its function is merely to put the refrigerant in such condition that the refrigerating cycle may again be started. It exerts little influence upon the efficiency of performance of the remainder, or greatest part, of the cycle. It is here that concerted action seems to be needed. This is not to say that refrigerating apparatus other than the compressor is not now commendable. But that there is room for improvement, no one will deny.

Competition invariably is healthy. Yet it is our opinion that closer co-operation of builders is more urgent just now. There are several channels through which this may come, and some of these are already organized. The American Society of Refrigerating Engineers offers one of the best. The possibilities which the society offers in this direction are not sufficiently taken advantage of; there seems to be reluctance to present papers at yearly and semiannual meetings, and often discussion is too contentious, too argumentative. There is need of papers that deal with specific, authentic performance data. The subject itself is really of less importance; it is bound to relate to refrigeration. There may be serious obstacles to the creation of a research laboratory such as the American Society of Heating and Ventilating Engineers maintain at Pittsburgh; but we doubt it. The various associations in the great industry of refrigeration could well afford such a laboratory.

Would it not be worth while to endeavor to get the American Society of Refrigerating Engineers, the association of refrigerating-machinery manufacturers, the many large ice associations, the packers and the very influential American Warehousemen's Association together and discuss the formulation of plans for the creation of a real research laboratory, a clearing house for ideas, safety measures, appliances and performances? There is no doubt that the various universities and engineering institutes would be of material assistance.

Regional Power Development

AT THE present time a great deal of interest is being given to working out a comprehensive power system for the industrial regions situated around Philadelphia, New York and Boston. The ideal power system, if such were possible, is one that would supply all the needs of the community for light, heat and power. In such a system it would be possible to operate at the highest load factor, to take advantage of the high efficiency of large generating units and also realize the high efficiency of a combination heating and power load. However, for obvious reasons, except to a very limited degree, no attempt has been made to combine all these factors in one system. In this issue on page 824 is an abstract from a discussion on "Regional Power Development and the Low-Temperature Distillation of Coal," by C. M. Garland, in which he says:

> In the central and northern portions of the United States every industrial plant for from seven to eight months out of the year requires fuel for heating. In seventy-five per cent of these plants the fuel required for heating is more than sufficient to generate the power required for manufacturing operations. For practical purposes it may therefore be considered that the power is obtained during these months without fuel expenditure. This explains why only thirty per cent of the industrial plants buy their power. Of this thirty per cent twenty per cent would doubtless be better off if they had efficiently operated plants and generated their own power. The writer is a strong advocate of central-station development, but believes that it is well to recognize the limitations imposed by existent conditions.

Mr. Garland, according to his arguments, sees the correct solution to regional-power development in the byproduct system of gas generation with the low-temperature distillation of coal. Such a system is now in successful operation in England. However, there are many arguments for and against this scheme. If, as Mr. Garland says, there are in the five-hundred million tons of bituminous coal burned in this country each year, two and one half billion dollars' worth of by-products burned up, then the saving of even a small portion of this tremendous waste is worthy of the most serious consideration. The cost of obtaining these by-products and what effect a national attempt at producing them would have on their price is something that Mr. Garland does not explain. Furthermore, if gas can be used economically for heating purposes, when compared with coal, it has got to be sold at a very low

figure, probably thirty per cent of what the average is for artificial gas today. Another feature is the limited distance to which gas can be economically piped. Taking Mr. Garland's figures, this limit is a radius of about fifteen miles.

There is little doubt that a system such as suggested by Mr. Garland could be used to advantage in certain localities, but has its limitations, like all the other schemes proposed for the development of regional power. When all the factors are given their proper weight in the ideal power system equation, the best that can be seen at this time is a compromise. If the National Government makes an appropriation to investigate the possibilities of regional-power development, it should be for a consideration of all systems having reasonable prospects of economically eliminating the waste in the present methods of power generation and distribution, and not for any particular scheme.

A New Artificial Fuel?

A RECENT report states that an Italian chemist has succeeded in preparing hydrogen for use as fuel in internal-combustion engines. As usual, this report stirs up the old discussion on the possibility or probability of the use of artificial fuels.

Without knowing anything of this new process, it is safe to say that its success is unlikely, although it may be possible. The use of any substance as fuel depends upon its ability to combine with some other substance, usually oxygen, in such a way that energy is given off. This energy is usually available in the form of heat energy and can be transformed into mechanical or electrical energy by means of the ordinary power-plant apparatus.

Most of our natural fuels are largely made up of carbon and hydrogen and give up their heat on uniting with oxygen. This process results in the formation of carbon dioxide and water. These two latter compounds will not unite with more oxygen and give up more heat. You cannot burn either of them. Many people, however, have conceived the idea that if these two compounds could be broken up into their original elements, the combustion process might be repeated again and again without limit. It is a comparatively simple matter to break carbon dioxide up into carbon and oxygen or water into hydrogen and oxygen. There is, however, a well-established chemical law that if a certain amount of heat is released during the formation of a compound, exactly as much heat must be supplied to break the compound up into its original form.

It is just this law that stands in the way of any truly artificial fuel. You cannot make a fuel without paying just as much heat as you would get out of it in burning it. Our so-called natural fuels are simply substances that have been put into "burnable" form by processes of nature. Just what these processes have been is still a subject of more or less scientific controversy, but unquestionably energy in some form was supplied for their completion. Nature paid the bill and man gets the benefit.

From this standpoint the reported artificial fuel is not and cannot be what the name ordinarily implies. It may be that the Italian chemist has found some new compound from which hydrogen may be liberated without the expenditure of as much heat as will be generated when the hydrogen is burned. If this be true, he has not produced an artificial fuel, but has rather discovered a new natural fuel. The value of his discovery will depend largely on the amount of this newly found substance which exists, not on any amount he can make.

In passing, it is worth noting that hydrogen as an industrial fuel is extremely delicate stuff. Properly controlled, it can furnish a great deal of energy per pound, but if it gets out of control it has enormous possibilities for trouble.

It is becoming quite general practice to integrate both the kilowatts and the wattless component in order to determine the weighted, or what might be called the average power factor, over a given period. However, the calculations to obtain the power factor from kilowatts and wattless component are somewhat involved. This problem has been reduced to a very simple form by the use of the chart given on page 795 of this issue, by C. Harold Berry. Since a high degree of accuracy is not required in measuring the power factor, the size of the chart as published will be found adequate for most all practical purposes.

What would be the effect, where two or more alternators are operating in parallel, of reversing the polarity of the field poles of one machine and trying operating it in parallel again with the other machines, to those who have not given consideration to the subject, may appear an involved problem. In this issue, on page 810, B. A. Briggs, in answering the question, has represented three-phase alternators with ring-type armatures. This explanation is a good illustration of how many of the questions regarding the parallel operation of such machines may be analyzed by this method.

If you are planning to store coal for next winter's peak load, no time should be lost in preparing the storage place. A recent paper in *Power* pointed out that a great deal of trouble with coal in storage arises from faulty conditions due to hastily planned storage facilities. It doesn't pay to wait until the coal arrives to get the rubbish off the ground where it is to be piled.

Your engines may be running without a knock, but what is happening in your boiler room? Do you know how much fuel is making steam and how much is being wasted? Present fuel conditions make possible, and even necessary, refinements in boiler-room practice which would have been rank extravagance a very few years ago.

A process requiring twenty tons refrigerating effect concentrated into eight hours calls for a plant of sixty tons rated capacity. A coal requirement of five hundred million tons concentrated into part of the year calls for a coal production capacity of seven hundred million tons. Every coal user can do his part toward correcting this evil.

The engineer who begins to overhaul the heating system as soon as the steam is turned off is the one who will be ready for cold weather when next fall comes. The public begins to think about heat in September, but it is the engineer's business to think about it in May. Don't be caught napping.

CORRESPONDENCE

Repairing a Boiler-Plate Lamination

In the article in *Power* of March 30, page 519, entitled "Repairing a Boiler-Plate Lamination," the writer expressed the opinion that welding up the lamination on a boiler shell of a horizontal-tubular boiler is all right. I do not agree with the author as to this, and if I were the inspector, I should reject the patch as applied. I do not believe that any shell or surface in which that part is subject to a tensile stress should be allowed to be welded by the acetylene or by the electric process. I would allow welding on flat surfaces provided they were stayed. It is the rule in the shops where I am working that any round or flanged surface cannot be welded and only such flat surfaces as are properly stayed. The Ohio state law does not permit acetylene or electric welding on boiler parts subject to tensile stress.

I have seen electric welding that looked like a very good job, but upon pressure being applied it was found that the weld was full of pinholes. Is the writer of the article under discussion sure that the patch welded is properly done and that the metal fused together as it should? In recent explosions on locomotives there has been a considerable number that gave way in the welded seams of the crown and side sheets. In order to make the job properly, I would cut out the laminated part and apply a patch to the shell with rivets; then I would be certain that the patch would pass the inspection of any inspector.

CHARLES W. CARTER, JR.

Olean, New York.

Pressure-Temperature Scales for Low-Pressure Steam

In the operation of feed-water heaters, condensers and similar apparatus it is often desirable, and sometimes necessary, to know the temperature of vaporization corresponding to a given absolute pressure, or the water-vapor pressure corresponding to a given temperature. The scales given in the figure show the corresponding absolute pressures and temperatures for pressures below atmospheric. The absolute pressure is found by subtracting the vacuum-gage reading from the barometer reading, both in inches and mercury.

The two upper scales give the temperatures for each hundredth of an inch pressure from 0.1 in. to 2.0 in. The three lower scales give the values for each tenth of an inch over the range from 2 in. to 30 in.

Detroit, Mich. C. HAROLD BERRY.

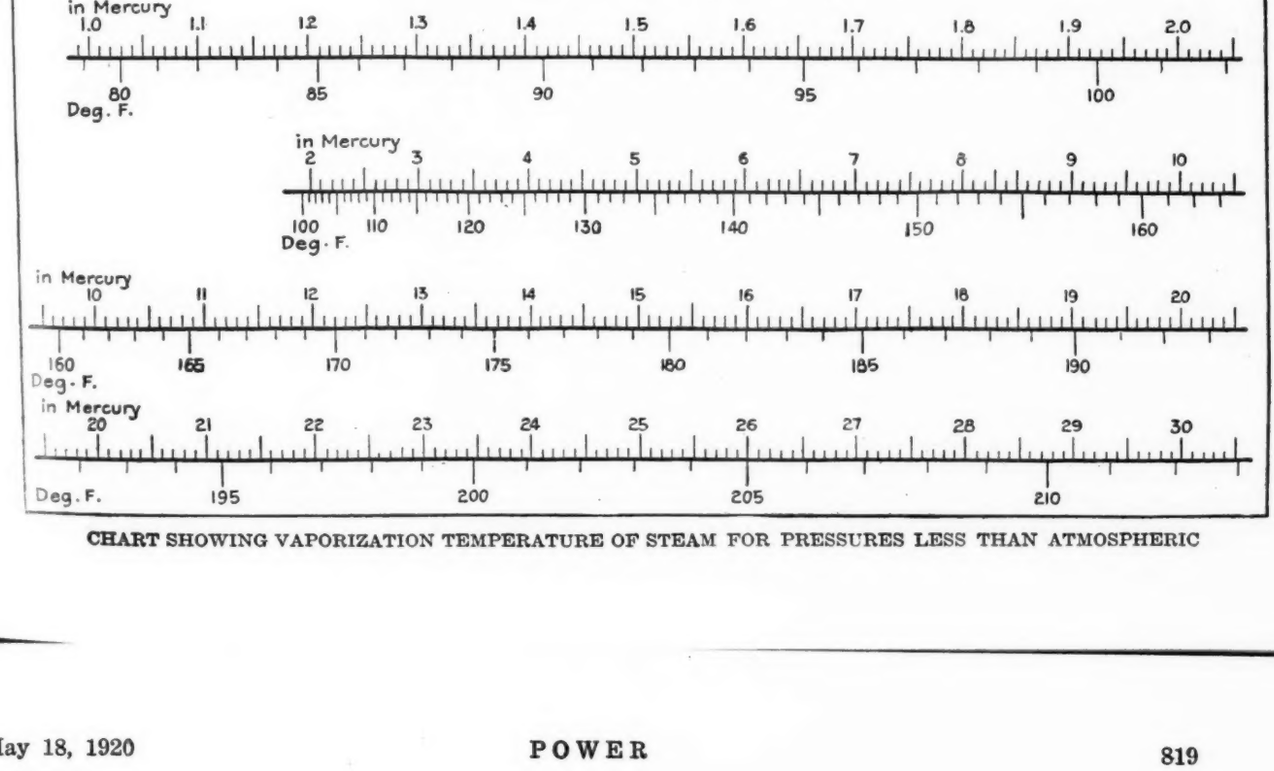
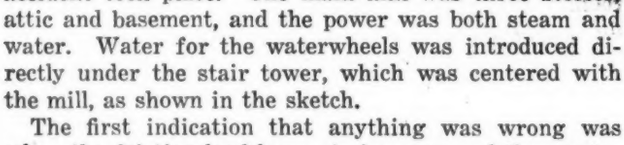


CHART SHOWING VAPORIZATION TEMPERATURE OF STEAM FOR PRESSURES LESS THAN ATMOSPHERIC

Why the Mill Settled

Some years ago I was employed in a mill where a near accident took place. The main mill was three stories, attic and basement, and the power was both steam and water. Water for the waterwheels was introduced directly under the stair tower, which was centered with the mill, as shown in the sketch.

The first indication that anything was wrong was when the friction load began to increase and the master



BROKEN FLOOR BEAM CAUSED SHAFTING TO SETTLE

mechanic gave instructions to have the shafting hangers and drives looked over. When the level was applied, the shaft in one of the rooms was found to be about two inches low midway of the mill, and the two floors above were in the same condition. Therefore, the "mechanics" started to level the shafting, by cutting into the cross-timbers of the mill, as shown at *B*. As I did not believe in weakening the structure, I entered a protest at the first cut, but without avail. I then told the agent the men were ruining his mill and that if they kept on it would fall down. This rather startling statement had the desired result, and he started for the mill.

The master mechanic had his line of argument all prepared, and *C* explains it. He said that he had either got to put the shafting up where it was down or put both ends down to match the center. He couldn't put the end that was in the wall down without tearing the wall all out and he wouldn't do that. As a matter of fact, he was only cutting into the timbers two inches and that wouldn't weaken them even a little bit, as he said.

The next morning my fireman acted a trifle fidgety, and finally he said that he believed that the mill was settling in the center over the water-way, which upon investigation proved to be so. The timber *A* had broken as shown at *D*, and the center of the mill was gradually sinking. Steel I-beams were put in place over the tail-race, and everything was made safe.

New York City. C. W. PETERS.

What Caused the Crack?

Some time ago a boiler that had been bagged came to my notice. The plant owner tried to employ a boilermaker at the time, but being unable to do so, a workman from the plant drove up the bag and in so doing, the metal buckled at the center. Two holes were drilled and filled with ¾-in. rivets. Some eight months later the engineer decided to have the plate straightened up; so a boilermaker was employed and was very successful in getting the sheet in good shape again. The next morning, upon getting ready to put in the two rivets, a crack 16 in. long was found extending across the sheet. The metal had been heated to a cherry red and let cool gradually, and no water entered the boiler during this operation. The sheet was cut out and replaced by a patch. When broken open at the crack, the damaged plate looked more like gray cast iron than boiler steel, it was so crystallized. H. SYLVESTER.

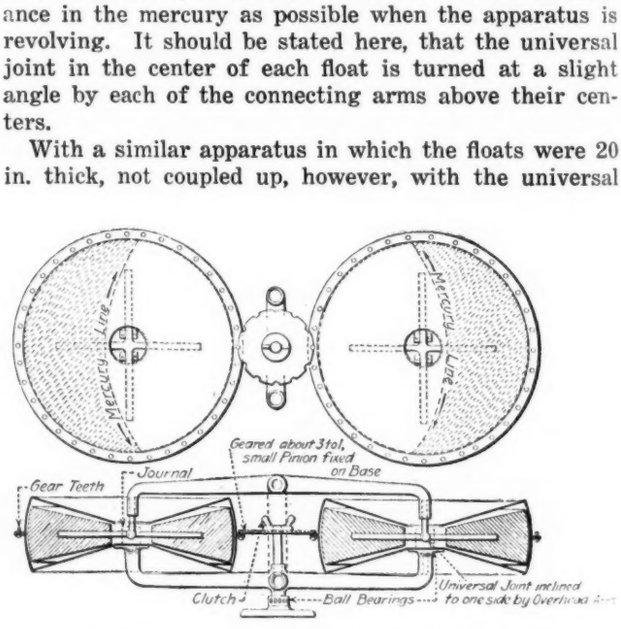
Concordia, Kan.

Mr. Bissel Has Found Another Perpetual Motion

The following should prove of interest, to the curious at least. In the illustration two cylindrical tanks are shown pivoted to a main frame on ball bearings. The main frame in like manner is centrally swung on a vertical shaft integral with the base and is also suspended on ball bearings. At the top of the central shaft is a gear proportioned about three to one with the cylindrical tanks, as indicated in the illustration. Inside of each tank is a closely fitting float, which operates similarly to the cork float in a modern gasoline-engine carburetor. In this case it is hinged on two journal boxes near the center of each tank.

Enough mercury is placed in the tanks to fill about one-half of the space between the outside and the float. Care should be taken to design the rotative size and shape of each tank with reference to the float, so that a maximum movement may be obtained and the mercury flow easily, using the least amount thereof. All parts should be carefully adjusted, one to the other, and smooth surfaced, so that there will be as little disturbance in the mercury as possible when the apparatus is revolving. It should be stated here, that the universal joint in the center of each float is turned at a slight angle by each of the connecting arms above their centers.

With a similar apparatus in which the floats were 20 in. thick, not coupled up, however, with the universal



MR. BISSEL'S PERPETUAL-MOTION MACHINE

joint, on account of faulty alignment, it was found that by using water instead of mercury and revolving the apparatus by hand, a regular up-and-down motion of the floats resulted. There was power enough to break a thread, also to lift a small weight up and down at every half-turn of each tank. It did not appear to take any more power to revolve the apparatus, whether the floats were secured or allowed to operate. Therefore the conclusion seems to be that energy was being produced.

Pittsburgh, Pa. JOSEPH E. BISSEL.

Height of Return-Tubular Boilers Above Grates

We note with interest your answer to E. G.'s question in the Feb. 10 issue of *Power* relative to the proper distance above the grates for setting 72-in. horizontal return-tubular boilers, and your answer to John A. Stevens' criticism in the issue of March 30.

It is our practice to set boilers of this size 60 in. over the grate to the under side of the shell. We have no records of complete tests on boilers installed in this manner, but we do know that there is a positive saving in fuel and a marked elimination of smoke in plants where we have replaced boilers set in the old way.

With a boiler setting properly constructed and insulated, we believe there would be very little difference in infiltration and radiation loss, due to the additional height of the setting. The increased combustion space is particularly adaptable to higher ratings, and in our opinion a return-tubular boiler can be most economically operated at from 125 to 150 per cent rating.

Boston, Mass. DAVID MOULTON.

Relative to the correspondence on the height of return-tubular boilers above the grates, page 517 of the March 30 issue of *Power*, I would say that during the month of September, 1917, a test was run upon the No. 2 power plant of the Whittenton Manufacturing Co., Taunton, Mass., under my direction. This plant contains ten 72-in. Wickes horizontal return-tubular boilers, nine of which were run during a week's test of 168 hours. The fuel used was "Alpha special" run-of-mine bituminous coal from Cambria County, Pa.

These boilers were set at a height of four feet from the grate to the under side of the shell and were installed under the direction of John A. Stevens. A record was kept of all the coal burned and the water evaporated during the week, and the average efficiency of boiler, furnace and grate was 67.79 per cent. The boilers were operated from 6:40 a.m. to 5:30 p.m. at 117 per cent rating, from 5:30 to 9 p.m. at 57 per cent rating and banked for the remainder of the 24 hours. Fires were buried down and cleaned from 6:30 to 9 p.m., which caused a loss of 2 per cent in the average efficiency.

No attempt was made to instruct the firemen in any way, as the object of the trial was to find out what was obtained from the plant in regular weekly operation. It is probable, however, that the firemen did a little better than usual owing to the presence of our observers in the plant. I consider these results very good for a mill boiler plant. FRED B. COLE,

Assistant Engineer with Charles T. Main.

Boston, Mass.

I am in charge of a plant that, when I came to it five years ago, had five 60-in. x 16-ft. return-tubular boilers set 24 in. above the grate. A shaking grate was used and in very cold weather the boilers were overloaded. We could burn up to 8,000 lb. of coal per boiler per 24 hr. very well, and our evaporation was about 10 lb. of water per pound of coal as fired, but at times we had to burn 10,000 lb. per boiler and our evaporation would always drop at such rates of combustion.

I wanted to drop the grates 12 in. but the mechanical engineers who do the consulting and lay out new work objected, saying I would spoil the looks of the plant and not improve on the evaporation.

I then asked for an extra boiler, but as there was not room to install one without building onto the plant I did not get it. I then talked them into letting me change the grates and lowered them 9 in. in front and 12 in. at the bridge wall, giving a 3-in. pitch. Castings were made crescent shaped to fill in the fronts and when the job was finished they said, "It don't look so bad after all." I can burn 10,000 lb. of coal per boiler per 24 hr. now and keep the evaporation up as well as we could on the 8,000 lb. basis.

This last year we installed a 72-in. by 18-ft. boiler and when I received the prints from the same engineers I was somewhat surprised and delighted to see the boiler was to be set 4 ft. 6 in. above the dead plate. We have what is termed a hand stoker set under it with a pitch of 18 in., making 6 ft. from rear of the grate to the shell of the boiler. Although I have not had a test run on this boiler as yet, to determine the economy, I have handled it enough to know it is doing good work.

We are running with a draft of from 0.25 to 0.3 in. of water in the furnace. We are burning 20 lb. of coal per sq.ft. of grate per hour and recently with three of the smaller boilers, one of which was banked 5 hr., and one banked 20 hr., we burned 44,400 lb. of coal. This averages over 21 lb. of coal per square foot of active grate per hour, not figuring what was used for banking.

I think we would have done better not to have run the boilers quite so hard and to have used one of the banked boilers a few hours longer, but the men don't always start up a banked fire when they should.

This coal was all handled by one man on each 8-hr. watch, except in the morning from 7 to 9, when I put on an extra man.

The coal and ashes are handled by coal passer and I think the men earned their money. I don't think this load could be carried on a boiler set 30 in. from the grate. I may be wrong and will be glad to be set right. In some of former issues of *Power* I have read some very interesting articles by Prof. Breckinbridge, and I would like very much to see what he may have to say about settings for return-tubular boilers.

Andover, Mass. W. C. RICHARDS.

Merits of Chain and Ring Shaft Lubrication

With reference to Mr. Wineberg's communication on the subject of chain and ring lubrication in the April 6 issue, I can say that I have had considerable experience in designing heavy ring-oiling bearings for rolling-mill and factory service, some of them being as large as 20 in. diameter, and running at 80 r.p.m. and the smaller sizes running up to several hundred revolutions. I have always had considerable success with the ring-oiling type, which I adopted in preference to the chain.

The main bearing of a high-speed engine that I once had under my supervision was fitted with a chain, and had it been practicable I would have changed it to ring oiling. The chain had a bad habit of becoming kinked, which caused it to jam, and of course the bearing went up in smoke. This invariably happened at the most critical time, when the engine was carrying its full load, and then it was a case of shut down and start up the other engine, which we were lucky to have available. I do not maintain that all chain-oiling bearings are

unsatisfactory, but my observation and experience have led me to the opinion that the ring-oiling bearings are more reliable and satisfactory in every way, giving little or no trouble, especially in heavy-duty drives, where reliability and economy in operation are matters of considerable importance. JOHN J. MUIR.

Seattle, Wash.

Three Power Plant Kinks

The following "stunts" may be of use to some of the readers of *Power*. For instance, most engineers use a brass plug in the cross connection below the water column. I formerly used them also, but after finding that any kind of an ordinary pipe plug is hard to remove after the square head becomes rounded, I adopted the plan shown in Fig. 1. That is, I made two long brass plugs threaded at one end so as to use a pipe wrench on them. Since then I have had no further trouble. An ordinary pipe nipple capped on the end could also be used. Fig. 2 shows a kink that I have found useful when making repairs and adjustments on medium-size Corliss and side-crank engines. It consists of a piece of wood fitted with cleats to fit between the legs of the cylinder and engine frame. A long lever inserted between these cleats and brought against the crosshead pin nut permits of moving the crosshead. In one of our 160-hp. boiler furnaces we had trouble with the side walls bulging and falling down. After I had anchor-irons, made of ¼ x 1-in. iron and 8¾ in. long, placed as indicated by Fig. 3, no further trouble was had. Some claimed that the anchors would burn off, but we found that they did not. GEORGE J. LITTLE.

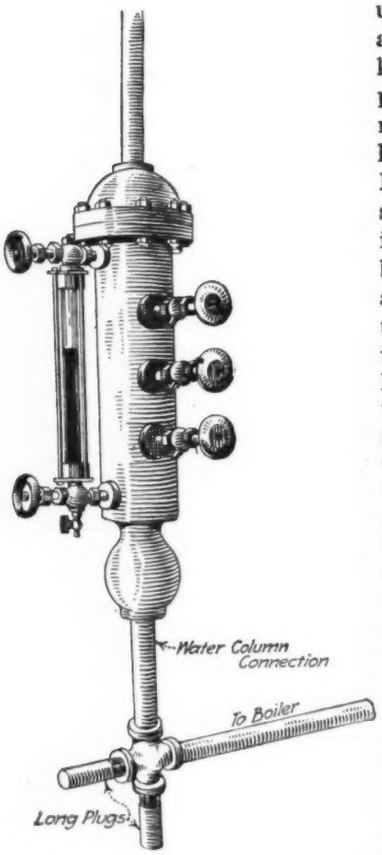


FIG. 1. LONG PLUGS IN CROSS CONNECTION

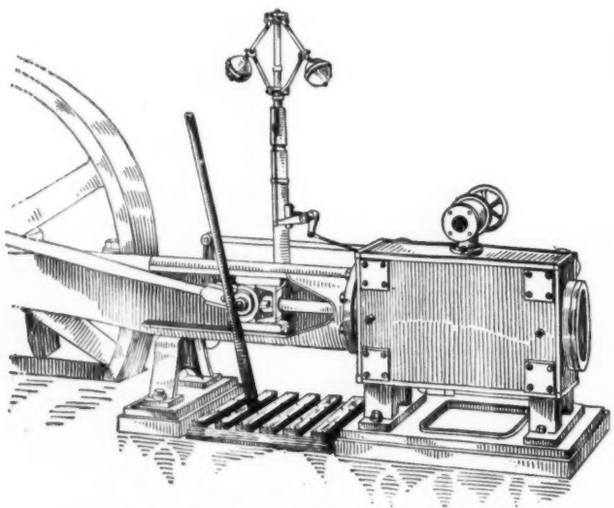


FIG. 2. LEVER FOR MOVING CROSSHEAD

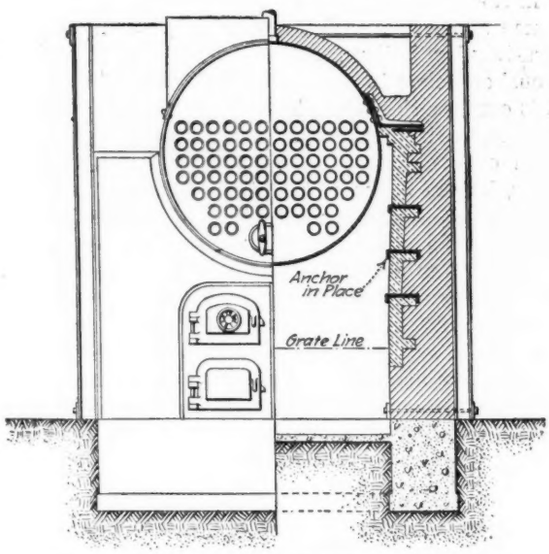


FIG. 3. ANGLE IRONS IN FURNACE WALLS

Hasbrouck Heights, N. J.

Electric Service in New England

Today electric service is available in practically every community in New England. This service may be supplied by a small municipal "electric-light plant," a small generating station under private control, a syndicate of small stations or a local substation fed from a large central station many miles distant. The recent movement to interconnect these different systems by a network of high-tension lines has brought to light some peculiar conditions.

The service ranges from direct current to 133-cycle alternating current. Voltages cover a similar wide range, while the number of phases is limited to 1, 2 and 3. The need of standardization of electric service is evident.

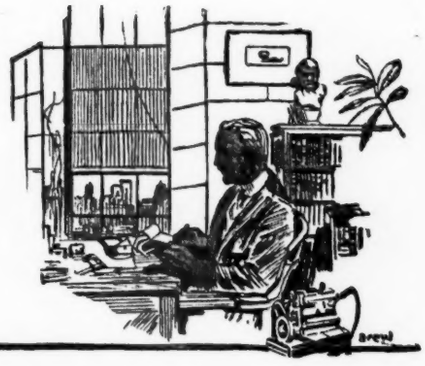
In this assortment of frequencies 60 cycles is the popular choice. Many systems of lower frequency have been changed to 60 cycles, and the last 133-cycle system in New England is now being changed over for 60-cycle operation.

Single-phase service for lighting and small-power installations is usually 110 volts, 60 cycles. Distribution transformers are often arranged for two 110-volt circuits and one 220-volt circuit on the low-voltage side. The lighting load is connected to the 110-volt circuits and the small-motor load is connected to the 220-volt circuit.

For power service, three-phase, 220 volts, 60 cycles is considered standard for small installations and three-phase, 440 volts, 60 cycles for larger installations. Apparatus for use on these circuits is considered standard by most manufacturers. This allows the customer a lower price and better delivery than would be possible if this apparatus were special. H. S. RAMSAY

Arlington, Mass.

INQUIRIES OF GENERAL INTEREST

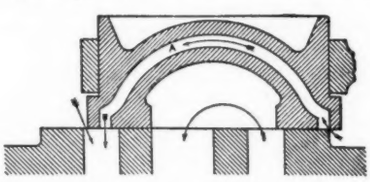


Provision for Smoke Connection to Stack.—A return-tubular boiler that has thirty-six 3-in. fire tubes has the grate area reduced to 6 sq.ft. What size of smoke connection should it have to a 40-ft. chimney that has a 2 x 2 ft. flue? C. E. S.

A 12-in. diameter smoke pipe with easy bends at angles would be sufficient for the present grate area. But to provide for future enlargement of the grate, with maximum draft area of the tubes, it would be well to supply a stack connection about 18 in. in diameter, in any case providing a damper in or near the smoke uptake of the boiler.

Trick's Slide Valve.—What is the difference between a Trick valve and an ordinary *D* slide valve? F. A.

The main difference is that Trick's valve affords double admission. Live steam is admitted past the outer edge of the valve just as with the ordinary *D* slide valve and additionally through a passage *A* in the valve, as shown in the



sketch. When the outer edge of the valve uncovers the port for admission, the port of the passage *A* at the opposite end of the valve is also uncovered, thus giving a double admission of steam, the same as a double-ported valve. This valve does not, however, give double exhaust, as the passage *A* is not opened to the exhaust.

Color for Natural-Gas Flame.—In the use of a natural-gas burner should the flame show bluish or straw color? E. M.

A white or straw-colored flame is indicative of incomplete combustion, usually due to poor mixture of air or insufficient air supply, and although there may be greater capacity, there is less economy and more soot than from a blue flame. While a blue flame is representative of more perfect combustion, it may be less economical than a white or yellow flame if there is an excessive air supply. For best results the air supply should be just sufficient to prevent a white or straw-colored flame.

Discharge of Condensate from Drying Cylinders.—On a paper machine that is provided with 30 dry cans or cylinders, do the cylinders become alternately filled and emptied of water, or is siphonage of the condensate continuous? P. H.

If the same steam pressure is maintained in all of the drier cylinders connected to the same drainage header and the discharge pipes and connections to the header are large enough to carry off the water as formed, then the condensate will be discharged continuously and with all cylinders containing the same depth of water. If the siphon pipe or siphon connections of a cylinder are too small, or the pressure maintained within a cylinder is below that within other cylinders connected to the same drainage header, the cylinder with lower pressure will fail to discharge or will discharge only intermittently, and conditions seldom are favorable for that cylinder to become completely emptied of water.

Advantages of Two-Stage Air Compression—What are the advantages of two-stage compression of air over single-stage compression? C. H. L.

Two-stage compression is adopted for the purpose of cooling the air and thereby obtaining a reduction of volume before the final compression. Intercooling, as by circulation of water, is an essential detail for obtaining any advantage from two-stage compression. The advantage over single-stage compression is an appreciable saving of power and the avoidance of the high temperatures, thus permitting of more satisfactory lubrication and less discharge in the air receiver and piping system to cause fires and explosions, and less drop of pressure from cooling of the compressed air.

Economy of Direct Steam Pumps—What is the average steam consumption per horsepower-hour of small duplex boiler-feed pumps of sizes such as 6 x 4 x 6 and 8 x 5 x 10, when operated with steam at 100 lb. pressure? L. S. J.

The steam consumption of direct-acting steam pumps is necessarily very high, as steam must be admitted to follow full stroke, the piston speed is low, the percentage of cylinder clearance is much greater than in ordinary steam engines and generally such pumps are operated against high back pressure. All these conditions are more detrimental to economy in the smaller sizes of pumps, and for ordinary sizes used for boiler feed pumps, such as 6-in. x 4-in. x 6-in. or 8-in. x 5-in. x 10-in., direct-acting pumps have steam efficiencies less than one-tenth that of a good engine; that is, they use from 150 to 200 lb. of steam per indicated horsepower per hour. But where the exhaust can be utilized for heating boiler-feed water, or displaces the expenditure of live steam for heating purposes, the excessive steam consumption per horsepower-hour becomes a negligible consideration.

Wattmeters Require Adjustment.—On one of the feeders going out from our plant the voltage is stepped up from 2,300 to 13,200 and, at the end of a five-mile transmission line, stepped down again to 2,300 volts. The power is metered on the 2,300-volt side of the transformers at both ends of the line. Should not both meters register the same? As it is now, the meter at the out end of the line registers considerably more than the one at the power plant. V. A. S.

The two meters should not register the same; however, they are now doing the reverse of what is the correct condition. The instrument at the load end of the line should register less than the one at the power house, since the latter meters not only the power supplied to the load, but also the losses in the transformers and transmission lines, whereas the meter at the load measures only that which is supplied to the load. If both meters are correctly calibrated, the one at the load will register approximately 10 to 15 per cent less than the one at the plant. The ratios and connections of the instrument transformers should be checked to make sure they are correct, and then the meters should be calibrated.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Induction and Synchronous Motors for Industrial Applications*

By C. W. DRAKE
General Engineer, Westinghouse Electric and Manufacturing Company

A SUBJECT that is attracting much attention today is "plant power factor," although it is a problem which has existed ever since induction motors were first installed, somewhat over twenty years ago. This being the case, we are often asked why it is that so many years elapsed with little or no discussion regarding power factor, while now it is the talk of the hour. There are numerous reasons, some having to do with the industrial plant itself, some with the transmission line and generating station, while others are largely economic. The most active factor in bringing this question to the foreground is the fact that during the last few years the generating equipment, transmission lines and transformers of most central stations have become heavily loaded or overloaded, and in looking for a method of still further increasing their capacity and improving the regulation, the raising of the power factor has appeared to be the most simple and inexpensive solution.

Correct Sizes of Motors Important

In a plant equipped with induction motors there is a fairly constant value of wattless kilovolt-amperes that must be supplied for magnetization. For a given energy component—that is, a certain definite amount of work performed in the plant—a definite power factor will be obtained. Ordinarily, when speaking of raising the power factor, it is assumed that a portion of this wattless component will be supplied by a condenser, of the synchronous or perhaps the static type. There is, however, another method of raising the power factor, which should not be lost sight of, and that is by carefully testing the motors and seeing that each one is of the correct size for its particular work. In many instances power factor has been raised from 5 to 10 per cent by this method, and in exceptional cases as much as 20 per cent. In plants using shears, punches, rolls and other machines equipped with flywheels, a very low load factor is often obtained, and a careful study should be made to obtain the best combination of motor and flywheel. Frequently, it will be found that the motor is installed of sufficient capacity to actually perform the duty cycle without the flywheel. In one mill, which had a power factor varying from 40 to 60 per cent, there was found a special welding roll that was driven by a 200-hp. squirrel-cage motor. A heavy flywheel was also used, but as the motor had only about 2 per cent slip, it carried practically the entire load. This lasted only a few seconds out of several minutes, so that most of the time the motor was running idle. By a proper combination of motor and flywheel design it was possible to use a 50-hp. motor, which materially reduced the wattless kilovolt-amperes. There are many such cases in which the motor need have capacity only sufficient to supply the friction losses, while the flywheel will perform most of the working cycle.

Where Power-Factor Correction Is Difficult

Of course, with the best motor arrangement, it is impossible with an induction-motor load to obtain a power factor much over 80 or 85 per cent, although there are plants using 25-cycle service, that operate at approximately 90 per cent power factor. However, the majority of plants have a power factor nearer 70 than 90 per cent, consequently some form of corrective apparatus is required to raise the power factor to a value that will not carry a penalty in the power contract. Just what this value is, it is difficult to state, as there are nearly as many power-factor clauses as there are power contracts, but as a rule penalties are imposed on power factors below 85 or 90 per cent for large demands and perhaps 75 to 85 per cent for smaller loads. It is these small or medium-sized plants where power-factor correction is generally found most difficult, as for instance, in machine shops, planing mills and miscellaneous industries located in the cities where most of the motors are of small size and are started and stopped at frequent intervals. Synchronous motors are not well adapted for such service, and in order to be of value for power-factor correction, they must be on the line all the time that the plant is in operation. In the planing mill the shaving exhauster offers about the only opportunity for the use of a synchronous motor, and either a belted or direct-connected motor may be used. As ordinarily installed, a fan imposes extreme starting conditions; that is, it requires approximately full-load torque at synchronous speed. Even with induction motors it is customary to use a high-starting tap in order to bring the motor to as high a speed as possible before changing over to full voltage. Since the reason for installing a synchronous motor is to raise the power factor, it is evident that the rating of the motor will depend as much on the wattless component required for the particular plant as upon the mechanical load required to drive the fan, and in cases like this the kilovolt-ampere rating of the motor will probably be at least double that required to drive the fan. This excess capacity makes it possible to obtain the desired starting characteristics with a reasonable design of motor.

An investigation of industrial plants shows there are many like the foregoing, in which one or two places exist where synchronous motors may be used and correct the power factor for the entire plant. These motors will operate at a high leading power factor. Motors for such service should be designed practically the same as synchronous condensers; that is, to operate at nearly zero per cent power factor, since the mechanical load in many cases may be quite small. For most of these applications either a direct-connected or a belted exciter should be used, and the starting and control of these motors may now be made almost as simple as that of a squirrel-cage induction motor. In fact, there is quite an interest shown at present in automatic starters for synchronous motors, and these will undoubtedly tend to increase the use of synchronous motors in plants where it has previously been thought that there was not sufficient skilled labor for their operation.

Small Synchronous Motor Demand Increasing

For industrial service it is impossible to draw up a general specification covering the exact size of motor to meet every condition of starting, power-factor correction, etc. Each application will require individual attention, but the fact that in most cases the rating is two or more times the mechanical load will permit the use of normally designed motors.

As a considerable portion of any central-station load is made up of miscellaneous industries like those herein described, it would appear that there should be an increasing demand for synchronous motors operating at speeds from 600 to 1,200 r.p.m. and in capacities of from perhaps 75 to 100 kilovolt-amperes upward. The installation of such machines would correct the power factor at its source, which is the proper place, rather than transform and transmit the wattless current to some central location to be corrected, as is now often the case.

The direct-connected, slow-speed synchronous motor for driving large air compressors has become standard, so that as far as the customer is concerned, it is unnecessary to specify the motor-starting characteristics or even the horsepower rating. Co-operation between the motor and compressor builders has made it possible to supply exactly the

*Abstract from a paper presented April 21, 1920, before the Pennsylvania Electric Association at the William Penn Hotel, Pittsburgh, Pa.

right motor for each compressor. This is also becoming true in the ammonia-compressor or refrigeration field, although more variables occur here regarding the horsepower requirements than with air compressors. Such applications, however, are best worked out between the machinery manufacturers, and the customer is principally interested in a satisfactory operating unit. Motors for such service are ordinarily designed for 100 per cent power factor, so that the amount of power-factor correction obtained will depend principally upon the ratio of the compressor-motor kilovolt-amperes to the total kilovolt-ampere load in the plant.

There are certain industries that have total loads running into thousands of kilowatts, and much of this load is often made up of comparatively large, slow or medium-speed motors. For instance, in the rubber industry large numbers of motors from 200 to 800 hp. are used to drive mill lines, and with the usual form of gear drive motor speeds from 500 to 600 r.p.m. are common. Slip-ring induction motors have been generally used on account of their high starting torque and low starting current, but as the load on these mill lines is quite variable, a low power factor often results. Most of the present drives are equipped with magnetic clutches or clutch brakers, which in case of emergency, disconnect the motor from the line and bring the mill line to a quick stop. The slip-ring motor has ample torque to start the load, so that the clutch may or may not be used for this purpose, but the fact that clutches are ordinarily used, has made it possible to replace slip-ring with synchronous motors of similar or slightly larger rating.

Slow-Speed Synchronous Motors

Experience with refrigerating machinery has shown that synchronous motors may be built for extremely low speeds and yet give high efficiency and a reasonable cost. Consequently, it was a natural development in the rubber industry to suggest the elimination of the gear reduction and use synchronous motors at about 100 to 120 r.p.m. instead of 500 or 600 r.p.m. In this case the clutch has five times as much torque to transmit and becomes a very large and expensive piece of apparatus. Other forms of braking may be used, such as mechanically operated brakes, or plugging or dynamic braking on the motors. But as long as the clutch is required for starting, it probably offers the simplest method of stopping. If synchronous motors can be designed to approach the performance of slip-ring motors—that is, give full load torque or over at starting—then the clutches may be eliminated and some other form of braking considered. The point that it is desired to make here is that the tendency in all machine design, plant layout and motor application is toward simplicity and a minimum number of parts. If motors can be designed to perform certain functions without the use of auxiliary mechanical devices, it is a step in advance. Many such examples may be noted, as for instance, the elevator and reversing-planer motors which made it possible to eliminate the reversing belts, and adjustable speed, direct-current motors for machine tools, which eliminated the step pulley and most of the gear box. There is no doubt regarding the ability of synchronous motors to drive rubber mills and correct the power factor, but it is a question whether the present arrangement may be considered a logical or final solution. As it stands now, the motor characteristics meet only a part of the requirements and the clutch and brake supply the remaining ones, but it is futile to prophesy what the ultimate drive may be. Whether these motors should be designed for 100 per cent or 80 per cent power factor will depend on local plant conditions, but as a rule we believe they should be designed for 80 per cent, and then they may be operated at any power factor between 80 and 100, as desired.

Conditions Existing in Cement Plants

Very similar conditions exist in cement plants, where large numbers of induction motors are used on tube mills, crushers, etc., and many of these motors are rated at from 200 to 300 hp. In the early days of electrical development in cement plants, friction clutches were quite commonly used in connection with standard squirrel-cage motors in order to facilitate starting. After the exact starting and running conditions were better known, squirrel-cage motors of proper characteristics were produced, so that the troublesome clutches could be eliminated. Most cement plants have preferred the squirrel-cage to the slip-ring motor for such service, on account of its greater simplicity, although slip-ring motors are now installed in some mills in the larger capacities. This is another example where the characteristics of synchronous motors are not adapted to the work, and their use would in a way revert to early induction-motor practice with clutches. The difference now is, the advantage of power-factor correction may offset any expense and difficulty with the mechanical equipment, and it may also be assumed that much better clutches are now available than formerly. Consequently, in plants like these it should be carefully considered whether the power-factor correction desired can best be obtained by using synchronous motors in the manufacturing processes or whether better manufacturing conditions can be obtained by the use of induction motors, and the power factor corrected otherwise, as perhaps by synchronous motors on motor-generator sets, centrifugal pumps or synchronous condensers. The foregoing may be summarized as follows:

1. A very large part of the ordinary central station business consists of industries that are difficult to classify, either as to product or type of machinery used. In most of these, improvement in power factor may best be obtained by the use of medium- or high-speed synchronous motors used in much the same manner as the present induction motors. The proper choice or application of these synchronous motors will fall largely upon the power engineer of the central station, who is generally most familiar with the customer's power problems.

2. For any plants using compressed air or refrigeration in suitable quantities, complete equipments with synchronous motors are available, and as a rule very little engineering on the customer's part is required. In some cases it is possible to have the motor especially designed for the local conditions, but generally a much better proposition is obtained by accepting standard ratings.

3. In industries, like the rubber, cement, flour, etc., using large motors, it is possible to use synchronous motors for nearly any drive by means of necessary mechanical attachments. As the principal reason for using synchronous motors is to improve the power factor, they should be used first in those places where their electrical characteristics are best adapted, and their use in other places should be carefully considered to see if the same result could not better be obtained by some other arrangement.

Industrial-motor application work cannot be reduced to an exact science or formula, because the power requirements and motor characteristics are determined not only by the machine to be driven, but fully as much by the method in which it is operated. Consequently, each application requires careful personal consideration in order that all functions may be satisfactorily met.

Orville Wright Presented with John Fritz Medal

Orville Wright, pioneer in the development of the airplane and an honorary member of the American Society of Mechanical Engineers, was presented with the John Fritz Medal at ceremonies held in the auditorium of the Engineering Societies Building, Friday, May 7. Presentation of the medal was made by Comfort A. Adams, past president of the American Institute of Electrical Engineers, following an address by Major General George O. Squier, Chief Signal Officer, U. S. A., and Colonel Edward A. Deeds, formerly a member of the Aircraft Production Board. Benjamin B. Thayer, past president of the American Institute of Mining and Metallurgical Engineers and chairman of the Board of Award, who was to preside at the ceremonies, was absent owing to illness, and Charles F. Rand, of the Committee of Arrangements, presided in his stead.

The ceremonies were preceded by a dinner at the Engineers Club. Among those present were the members of the board and several friends of Mr. Wright.

Orville Wright was born in Dayton, Ohio, Aug. 19, 1871, and until 1888 he attended the public and high school of that city. Later he attended Earlham College, Indiana, until 1909, when he was graduated. His studies were completed at Oberlin College, Ohio, which he attended until 1910.

Orville is the brother of the late Wilbur Wright, and since 1903, he, with the aid of his brother, has worked on the development of the flying machine. The first test was made in North Carolina in 1903, and in 1905 the first successful long distance flight was made. In 1909 his efforts were recognized by the French Academy of Science and he was presented with a gold medal. He is a member of the Aëro Club of America, and his work in the development of the airplane will stand out as a monument of scientific achievement.

The John Fritz medal was established in 1902 in honor of John Fritz, of Bethlehem, Pa. It is of gold and is awarded only once each year, accompanied with an engraved certificate which states the origin of the medal, the specific achievements for which the award is made, and bears the names of the members of the board by which the medal was awarded and the signatures of the president and secretary of the board, which is formed of sixteen men, four representatives from each of the four National Societies of Civil, Mining, Mechanical and Electrical Engineers.

The first award of the medal was made to John Fritz at a dinner given to him on his eightieth birthday, Aug. 21, 1902, and since then fifteen awards, including the one to Mr. Wright, have been made.

Regional Power Development and the Low-Temperature Distillation of Coal

In the May number of the *Journal of the American Institute of Electrical Engineers*, C. M. Garland[1] takes issue with W. S. Murray on his scheme for the development of regional power for the industrial district along the North Atlantic seaboard. An abstract of a symposium "Economical Supply of Electric Power for the Industries and the Railroads of the Northeastern Atlantic Seaboard," on Mr. Murray's plan presented before the midwinter convention of the American Institute of Electrical Engineers, was published in *Power*, March 16, 1919. Discussing Mr. Murray's plan, Mr. Garland says, in part:

The writer is convinced, however, that no regional power-development scheme north of the Mason and Dixon line which contemplates the generation of power from coal is complete unless it provides heat for industrial plants in winter, and furthermore, that no regional power-development scheme contemplating the generation of power from bituminous or semi-bituminous coal is more than halfway complete if it does not contemplate the recovery of the byproducts from the coal.

In the central and northern portions of the United States every industrial plant for from seven to eight months out of the year requires fuel for heating. In 75 per cent of these plants the fuel required for heating is more than sufficient to generate the power required for manufacturing operations. For practical purposes it may therefore be considered that the power is obtained during these months without fuel expenditure. This explains why only 30 per cent of the industrial plants buy their power. Of this 30 per cent 20 per cent would doubtless be better off if they had efficiently operated plants and generated their own power. The writer is a strong advocate of central-station development, but believes that it is well to recognize the limitations imposed by existent conditions.

The great barrier to Mr. Murray's project is, therefore, the fact that the average plant can take advantage of the increased economy of the central station only from four to five months out of the year. During the winter season the same amount of coal would have to be hauled to furnish heat in so far as the industrial plants are concerned. The amount of coal hauled would therefore be reduced only by the amount of coal saved by the electrification of the railroads, which in this section would not amount to more than 20 per cent of the total. The writer, therefore, cannot see any great relief to railroad congestion unless some method of heating other than direct-coal firing is resorted to. It is also this coal for heating that leads to the overcrowding of railroad terminals during the winter months. Again, it is questionable if the poorer economy certain to result from the intermittent operation of boilers for the heating load in winter, assuming that the power load was taken by the central station, would not offset the saving effected through the electrification of the railroads. It is, therefore, quite certain that any regional power development that does not include also the distribution of heat will be extremely limited in its success, for with the present methods of electrical-power generation, it would never be possible to distribute electrical current for the heating of large areas at low temperatures.

In the United States where at least 500,000,000 tons of bituminous coal are burned annually, there are 10,000,000,000 gallons of tar and the equivalent of 30,000,000,000 pounds of ammonium sulphate, having a combined value of $2,500,000,000 burnt up with the coal. It is not practicable to save all of these byproducts, but a recovery of 25 per cent could reasonably be expected when it is considered that 80 per cent of the coal mined is used by industrial plants, public-utility plants and the railroads.

The remarkable part of all of this is that the means are at hand today and have been at hand for a number of years for carrying out the regional power development, the regional distribution of heat, the placing of every industrial load on the central station, the relieving of railroad congestion, particularly terminal congestion, through the reduction of the hauling of fuel, the reduction of the smoke nuisance in cities, and, in addition to these, the recovery of the byproducts from at least 25 per cent of the coal mined. I refer to the combination of the well-known Mond byproduct system of gas generation with the low-temperature distillation of coal.

In the Mond process coal is gasified in a special producer whereby the coal is converted into gas, tar and ammonia. The ammonia is recovered in the form of ammonium sulphate, which amounts to from 50 to 100 lb. per ton of coal gasified and has a value of about four cents per pound under present prices. The value of this byproduct, therefore, varies from $2 to $4 per ton of coal gasified, depending upon the amount recovered. The tar recovered from the straight Mond process represents about 6 per cent of the weight of the coal, and this tar consists principally of pitch which has little or no value.

The gas from the Mond process has a calorific value in the neighborhood of 140 B.t.u. per cu.ft. and from 65 to 70 cu.ft. of gas are obtained per pound of coal. This gas can be burned under boilers with greater efficiency than the coal and without smoke. It is also suitable for use in the firing of house-heating boilers and for small or large industrial furnaces. The gas can be piped economically within a radius of fifteen miles of the central station. This distance limits the size of the central station and to a certain degree does not accomplish everything that could be desired from regional power and heat distribution. It does, however, relieve railroad-terminal congestion, and it will in a large measure relieve main-line congestion, owing to the greater economy in the use of fuel and to the elimination of fuel hauled for the use of railroads.

By the low-temperature distillation of coal is meant distillation of coal at a temperature around 1,000 deg. F. When distilling coals at this temperature, a very small amount of gas is generated of high calorific value and a large amount of tar with a small amount of ammonia. This is a process which has been experimented with for years and which has been demonstrated on a practical scale by different investigators in this country and abroad. It has been definitely determined beyond question of a doubt that from 20 to 30 gal. of tar can be obtained from a ton of bituminous coal, something like 12 lb. of ammonium sulphate and from 1 to 2 cu.ft. of gas and about 75 per cent of coke.

The tar from this process contains considerable quantities of motor fuel and creosotes. It has been estimated that it would be possible by the splitting up of this tar to obtain from 15 to 20 gal. of motor fuel per ton of coal. Investigations indicate that in a crude state this tar is worth in the neighborhood of 10 cents a gallon.

The coke from this process would probably contain in the neighborhood of from 12 per cent to 15 per cent of volatile matter which would contain most of the nitrogen originally in the coal. By gasifying this coke in the byproduct gas producer, from 50 to 85 lb. of ammonium sulphate will be obtained per ton of coke gasified and from 65 to 70 cu.ft. of gas having a calorific value in the neighborhood of 140 B.t.u.

The low-temperature process will yield byproducts having a value of from $2 to $3 per ton of coal gasified. By gasifying the coke in the byproduct gas producer the

[1]Consulting Engineer, Chicago, Ill.

ammonia recovered will have a value of from $2 to $4 per ton of coal gasified, depending upon the amount recovered. In other words, by combining these two processes, by-products having a value of from $4 to $9 per ton of coal gasified may be obtanied.

I would not ask Congress, as Mr. Murray has suggested, to appropriate $200,000 to find out if there was a $300,000,000 waste in the Atlantic Coast States, for the same reason that I would not ask Congress to appropriate $200,000 to ascertain if the Statue of Liberty is still standing in New York Harbor. Every engineer experienced in power-plant economy knows that this waste exists and has a comprehensive idea of its magnitude. I would, however, ask Congress for an appropriation of $5,000,000 for the construction of a workable-sized plant along the lines of the combined Mond and low-temperature distillation processes. This $5,000,000, properly used, would bring greater returns to the American people than any money Congress ever spent.

Water-Power Bill as Reported from Conference Committee

The water-power bill, lately reported out by the Conference Committee of Senate and House, creates a Federal Power Commission to be composed of the Secretaries of War, Interior and Agriculture, to which is delegated authority over all matters pertaining to the development of water powers in which the Federal Government has jurisdiction or in which it is interested as owner of lands or other property necessary to such projects.

The commission may issue preliminary permits allowing applicants three years in which to make examinations of water-power projects, to prepare plans and to make financial arrangements. The commission may also issue licenses for a period of fifty years from the expiration of preliminary permits or it may reserve such projects, the development of which, in its opinion, should be undertaken by the United States itself, and must give preference to states and municipalities, provided it deems the plans for same are equally adapted to utilize the water resources of the region.

The bill encourages the building of headwater storage reservoirs with a view to equalizing power production, preventing floods, and, in arid states, the use of the water for irrigation purposes on the lowlands after the water has been utilized for the generation of power. Further provision is made for the construction of locks in power dams on navigable streams with a view to extending navigation into the upper reaches of rivers. At the expiration of the fifty-year license the Government is given the option of purchasing the hydro-electric plants by paying the licensee his net investment, or it may issue a new license to the original licensee upon reasonable terms, or to a new licensee who shall in that event pay the original owner his net investment in the plant.

Under the terms of the bill the United States may take over and operate any water-power plant under license in time of war for the manufacture of explosives or for any purpose involving the safety of the country. The commission is authorized to make reasonable charges to cover the administration of the act and for the use of Government lands and property, and to absorb excessive profits that cannot be prevented by regulation. Licensees are placed under supervision of state public-service commissions as to rates to be charged to consumers for power and also as to regulation of service. Severe penalties are provided for non-compliance with the terms of the act.

Senator Jones of Washington, chairman of the Water Power Conference Committee, in commenting on the necessity for utilization of the energy contained in our falling waters, said:

Through failure of Congress to pass water-power laws under which money could be safely invested with prospect of a fair return, water powers now wasting have been held back for years from development in at least twenty-two states of the Union. I am informed that actual water-power developments are projected to be undertaken upon enactment of this bill having a total capacity of over 4,000,000 hp. The completion of these projects would open 4,000 miles of the upper reaches of our streams and rivers to navigation. In this way cheap water transportation would be afforded to districts, now sparsely settled and congestion of traffic relieved in thickly populated centers through the investment of private capital instead of through river and harbor appropriations by Congress. To encourage water-power development is a national duty, as it cannot be considered a local or a sectional question. It concerns every citizen of the United States, whether he dwells in the vicinity of water power, in a city or upon the plains of Iowa. The things used and consumed in every household are affected by the price at which those things can be produced under the cheapest of conditions. The cost of food, of clothing, of fertilizers, of explosives, and the convenience and facility of transportation would all be beneficially affected by the development of water power to the utmost extent of its usefulness. Coal shortage brings up again the folly of leaving unused the nation's vast resources of water power. The more these are developed the less desperate will be the fuel stringency.

The labor of one man is released for other uses every time 50 hydro-electric horsepower is developed, and every 150 horsepower developed releases one coal car for other duty. Other countries are awake to the necessity of developing their water powers. A French corporation with $250,000,000 of capital is seeking funds in America with a view to undertaking the utilization of 700,000 hp. now wasting in the River Rhone, and incidentally these improvements will, through canalization, make it possible for steamers to go up the Rhone to its connection with the River Rhine and thence down the Rhine to the North Sea. Italy, which is entirely without coal, is about to develop her water powers on an immense scale. Spain is offering liberal concessions looking to the development of the water powers now wasting in the Pyrenees and other mountain ranges. Sweden is paying $46 per ton for coal, which she has to obtain from England, and therefore is proceeding with the work of developing as near as possible the entire 5,000,000 water horsepower contained within her boundaries.

The United States must not fall behind European countries in conserving its coal deposits and in developing the vast amount of cheap electric energy contained in its wasting water powers.

Senate May Attempt to Block Bill

The conference report on the bill is said to face a filibuster in the Senate. The bill agreed upon by the conferees was accepted readily by the House of Representatives. Only thirty votes were cast against the acceptance of the measure as agreed upon in conference. The votes for the report numbered 259. In view of the overwhelming sentiment in the House in favor of the legislation as it now stands, it is not expected that the attempt to block it in the Senate will be successful.

The opposition is confined almost entirely to the definition of navigable waters; to the license provision; and to the matter of distributing power to municipalities.

An amendment adopted by the Senate provided that a licensee should not discriminate in the distribution of power among municipalities that can be efficiently served and supplied with power. The conferees struck out the amendment.

The license clause as it was changed in the conference reads as follows:

That the licensee shall pay to the United States reasonable annual charges in an amount to be fixed by the commission for the purpose of reimbursing the United States for the costs of the administration of this Act for recompensing it for the use, occupancy, and enjoyment of its lands or other property; and for the expropriation to the Government of excessive profits until the respective States shall make provision for preventing excessive profits or for the expropriation thereof to themselves, or until the period of amortization as herein provided is reached, and in fixing such charges the commission shall seek to avoid increasing the price to consumers of power by such charges, and charges for the expropriation of excessive profits may be adjusted from time to time by the commission as conditions may require.

Argentina, Brazil and Uruguay are jointly considering plans for the construction of an international power plant on the Uruguay River. It is believed that 2,500,000,000 kw.-hrs. per annum could be developed, or an amount equal to that of 3,000,000 tons of coal. This is the largest project contemplated at the present time.

A New Process for the Preparation of Lubricating Oils

In a paper presented before the National Petroleum Association in Pittsburgh on April 22, H. M. Wells and J. E. Southcombe, of London, England, advanced some rather revolutionary ideas on the theory of lubricating oils. Briefly, they claimed that by the use of their "Germ Process," oils of any desired characteristic and of increased lubricating powers might be prepared very cheaply.

Starting from the assumption that the lubricating qualities of an oil depend on its ability to wet the lubricated surfaces and therefore on its having a low surface tension, the authors investigated the interfacial tension of various oils against water and against mercury. They found from these experiments that this tension was much lower for compound oils and fatty oils than with straight mineral oils. After a great amount of investigation it appeared that this difference had some relation to the presence of small quantities of free fatty acids in the fatty or compound oils.

The next step was the preparation of oils consisting of 99 per cent mineral oil and 1 per cent free fatty acid which were found to have a low surface tension. The removal of the acids from fatty oils resulted in a high surface tension. The authors therefore decided that the lubrication value of an oil depends solely on the fatty acid content and that it should be possible to obtain the desired result by adding minute quantities of such acid to pure mineral oils.

Further experiments seemed to show that the addition of one class of acids induces a tendency to demulsify while another group of acids have a powerful emulsifying influence. It is therefore claimed that this process enables the producer to improve the lubricating properties of any mineral oil and at the same time obtain any desired emulsifying characteristics.

Another advantage claimed for "Germ Process" oil is that the amount of acid added is very small and is completely under control, whereas the use of compound oils introduces greater quantities of acid and in many cases hydrolysis results in the formation of large and uncontrollable amounts of acid. In other words, the new method furnishes just enough acid to make the lubricant "oily" and yet avoids any danger from corrosion.

Production of Electric Power and Consumption of Fuel

Data collected and compiled by the Committee on Division of Power Resources, United States Geological Survey, giving the production of electric power and consumption of fuel by public utilities plants in the United States for the month of January 1920, show an increase of approximately 15 per cent over the figure for the same month in 1919.

The figures for January are based on returns received from about 2,800 power plants of 100-kw. capacity or more engaged in public service, including central stations, electric railways and certain other plants which contribute to the public supply. The capacity of plants submitting reports of their operations is about 90 per cent of the capacity of all plants. The average daily production of electricity during January was 124,300,000 kw.-hr., 33 per cent of which was produced by water power.

The total production of electricity by public-utility plants during 1919 was 40.3 billion kilowatt-hours, 14.76 billion kilowatt-hours, or 36.6 per cent by water power and 25.54 billion kilowatt-hours or 63.4 per cent by fuels. The mean daily output for 1919 was 110.4 million kilowatt-hours. The mean daily production for January, 1919, was about 108 million kilowatt-hours; the mean for January, 1920, was 124.3 million kilowatt-hours. Note that the value for January, 1919, is estimated.

The fuel consumption for the year was as follows: 35 million short tons of coal, 11.05 million barrels of oil, and 21.7 million M cubic feet of gas. Converting the oil and gas consumed to coal, the equivalent coal for all fuels consumed during 1919 would be 38.347 million tons. With 25.540 billion kilowatt-hours produced by fuels in 1919, an average of practically three pounds of coal were required per kilowatt-hour of electricity produced. On this basis it would have required the consumption of 22,140,000 tons to have generated the kilowatt-hours produced by water power.

The estimated production of bituminous coal in 1919 is 458,063,000 short tons. The amount of coal used by electric public utility plants during 1919 was 7.6 per cent of the total produced.

PRODUCTION OF ELECTRIC POWER AND CONSUMPTION OF FUEL BY PUBLIC UTILITY POWER PLANTS IN THE UNITED STATES IN JANUARY, 1920

Thousands of Kilowatt-Hours Produced

State	By Water Power	By Fuels	State	By Water Power	By Fuels
Alabama	34,864	14,452	New Hampshire	4,322	5,166
Arizona	8,567	11,703	New Jersey	143	101,478
Arkansas	132	7,675	New Mexico	53	1,524
California	164,727	112,346	New York	227,033	382,108
Colorado	12,784	22,811	North Carolina	53,035	10,956
Connecticut	9,069	59,256	North Dakota	0	2,732
Delaware	0	6,807	Ohio	1,490	258,432
Dist. of Columbia	0	23,317	Oklahoma	217	17,287
Florida	965	10,890	Oregon	32,278	7,845
Georgia	43,816	10,696	Pennsylvania	45,324	329,392
Idaho	48,574	1,348	Rhode Island	355	37,114
Illinois	14,831	260,723	South Carolina	61,911	5,825
Indiana	2,943	91,788	South Dakota	477	3,327
Iowa	55,574	31,622	Tennessee	39,443	9,233
Kansas	1,741	35,986	Texas	74	55,397
Kentucky	0	23,409	Utah	13,932	0
Louisiana	0	18,126	Vermont	15,430	36
Maine	23,381	1,577	Virginia	13,801	30,453
Maryland	284	31,261	Washington	103,981	4,480
Massachusetts	22,009	147,936	West Virginia	1,775	95,306
Michigan	51,799	138,180	Wisconsin	35,443	37,451
Minnesota	28,053	36,157	Wyoming	152	4,785
Mississippi	0	5,886			
Missouri	5,720	54,082	Total	1,274,401	2,580,198
Montana	89,574	562	Total, by water power and fuels		3,854,599
Nebraska	909	20,436			
Nevada	3,416	119			

The production of the electric power reported required the combustion of fuels in the quantities indicated in the following table:

State	Coal, Short Tons	Petroleum and Derivatives, Barrels	Natural Gas, Thousands of Cubic Feet
Alabama	29,211	1,255	0
Arizona	198	42,473	0
Arkansas	8,675	4,888	155,222
California	0	545,829	179,563
Colorado	43,345	110	0
Connecticut	77,311	4,374	10,236a
Delaware	9,139	0	0
Dist. of Columbia	23,237	0	0
Florida	2,425	54,753	0
Georgia	21,179	19,605	0
Idaho	150	10	0
Illinois	411,719	472	0
Indiana	205,453	254	2,025
Iowa	94,185	576	0
Kansas	39,710	91,428	7,628b
Kentucky	45,149	188	0
Louisiana	7,589	60,528	68,510
Maine	3,410	49	0
Maryland	39,552	0	1,500
Massachusetts	173,088	1,764	0
Michigan	180,542	139	0
Minnesota	64,060	620	0
Mississippi	14,028	11,841	0
Missouri	91,997	90,657	0
Montana	4,206	22	1,257
Nebraska	37,926	16,503	0
Nevada	367	842	0
New Hampshire	6,768	0	0
New Jersey	156,280	136	280a
New Mexico	4,733	866	0
New York	478,533	763	72,579
North Carolina	21,992	34	0
North Dakota	19,362	150	0
Ohio	401,066	697	161,065b
Oklahoma	8,353	71,940	275,926
Oregon	190	3,657	0
Pennsylvania	532,761	5	49,937
Rhode Island	35,196	7,560	0
South Carolina	11,779	0	0
South Dakota	7,729	1,936	0
Tennessee	22,729	25	0
Texas	58,707	211,222	48,227
Utah	3	0	0
Vermont	1,748	2,146	0
Virginia	43,212	132	0
Washington	10,396	15,612	0
West Virginia	106,230	50	227,900
Wisconsin	64,626	544	0
Wyoming	14,418	4,217	3,300
Total	3,634,662	1,270,872	1,333,810

(a) Artificial gas. (b) Includes 61,520 artificial gas.

Dr. Frederick G. Cottrell, the New Bureau of Mines Director

Dr. Frederick Gardner Cottrell, chief metallurgist, Bureau of Mines, was nominated on May 5, by President Wilson, to be the Director of the Bureau to succeed Dr. Van H. Manning, whose resignation will take effect on the first day of June.

Dr. Cottrell was born in Oakland, Cal., Jan. 10, 1877. Following the completion of his elementary education, he entered the University of California, from which he graduated in 1896 with the degree of B.S. In 1901 and 1902 he attended the University of Berlin and the University of Leipzig, receiving the degree of Ph.D. from the former.

From 1897 until 1900 Dr. Cottrell was a teacher of chemistry at the Oakland High School. From 1902 until 1906

DR. FREDERICK G. COTTRELL

he was an instructor of chemistry at the University of California. In 1906 he was appointed assistant professor, which position he retained until 1911, when he became consulting chemist. Dr. Cottrell became the chief chemist at the University in 1911, and in 1916 he resigned to accept the position of Chief Metallurgist at the United States Bureau of Mines.

He is an active member in a number of societies, including the American Chemical Society, Mining and Metallurgical Society of America, American Institute of Mining Engineers, American Electrochemical Society, Sigma Xi, Phi Beta Kappa and Alpha Xi Sigma.

Foreign Trade Convention

The entertainment committee of the Foreign Trade Convention which is to be held in San Francisco, May 12-15, has planned several entertainment features in addition to the regular business of the convention. On May 16 there will be a trip to the famous Yosemite Valley, and a three weeks' excursion has been arranged to the Hawaiian Islands, beginning May 19. All the principal points of interest will be visited. Plans are also being made for a three weeks' trip to points of interest in southwestern Alaska.

U. S. Bureau of Mines To Develop the Commercial Treatment of Lignite

At least $300,000 is to be expended under the direction of the Bureau of Mines in an effort to develop a commercial treatment for lignite. An experimental plant is to be erected at New Salem, N. D., which will be able to carbonize at least one hundred tons of raw lignite per day and provide for the complete recovery of the liquid and gaseous by-products and for the handling of the char, which it is planned to make into briquets. Of the sum to be expended, $100,000 is appropriated by Congress and $200,000 is to be furnished by a subsidiary of the Consolidated Lignite Collieries Co.

It was the intention at first to put the experimental plant in the Texas lignite field, but the development of oil and gas in that region interfered with the market for the gas which would be produced in connection with the treating of lignite.

The Bureau of Mines is to provide the plans and specifications for the carbonizing and briquetting plant; maintain active supervision and oversight over the construction and operation of the plant; and furnish the necessary technical assistance The co-operating concern has agreed to provide a satisfactory site on its railway spur; to install certain portions of the equipment; to furnish the necessary lignite and other raw materials; to sell the products; to furnish the labor; and to conduct the necessary business activities of the undertaking.

American Association of Engineers Activities

The American Association of Engineers at the sixth annual convention at St. Louis, May 11, elected Leroy K. Sherman president.

The first convention of the Federal Government employees of the American Association of Engineers will be held in Washington on May 22. An advisory council will be elected for the department to determine a plan to form the country into districts for departmental work.

The first meeting of the North Dakota Chapter of the American Association of Engineers, held in Bismarck, April 23 and 24, was attended by the governor of the state and a number of prominent officials of the North Dakota State Highway Commission. The following officers were elected: Past president, E. J. Thomas, city engineer of Minot; president, J. E. Kaulfuss, assistant state highway engineer; first vice president, W. G. Black, city engineer of Mandan; second vice president, W. B. Stevenson, Fargo; and third, fourth, fifth and sixth vice presidents, L. T. Powers, William Barnock, Robert Jacobson and E. H. Morris, respectively.

A movement is on foot in Great Britain for the establishment of local sections by the Institution of Mechanical Engineers. As long ago as 1913 a meeting was held in Manchester with the object of finding facilities in the provinces for the institution of local branches, but the cost proved to be prohibitive, and it was decided instead to have the papers contributed to the Institution read in the provinces, and correspondents were appointed to arrange such meetings. Early in 1914 Sir T. Holland wrote to the *Manchester Guardian*, suggesting the organization of meeting places furnished with reference libraries, lecture rooms, etc., which would be supported conjointly by several societies. A committee on which the Institution of Mechanical Engineers was strongly represented was formed to discuss the matter, but the outbreak of the war put an end to the business. The institution is now adopting a by-law looking to activity along these lines.

That the mineral resources of India are rapidly being developed can be seen by statistics published in a recent issue of *Trans-Pacific*. In 1917 the total coal production of India was 17,642,798 tons and in 1918, 19,847,039 tons was produced. This shows an increase of almost 2,000 000 tons per annum.

Fuel and Oil Boiler Efficiency

Apart from the usual advantages attaching to the use of oil fuel such as decreased labor staff in the stokehold, facility of bunkering, etc., the fact should not be lost sight of that, owing to improved circulation of the water in the boiler, the efficiency of the boiler—that is to say, the percentage of the heat of the fuel which is actually given to the water in the boiler—is considerably increased. In the case of the ordinary marine boiler having cylindrical furnaces the fire bars are removed, and the burner is located at the center of the front of the furnace. It follows, therefore, that the furnace is heated all over its surface, and since the bottom part of the furnace is heated, it follows that the water in contact with this is also heated, and rising to the surface owing to decrease of density, is replaced by cooler water. It is well known that with coal-fired boilers the bottom part of the boiler often remains cold for many hours, and perhaps for a day or two, after the fires are lighted. With oil fuel this is prevented, and the resulting improvement in the circulation greatly increases the efficiency of the boiler and at the same time reduces the possibility of local strains. In a recent test of an ordinary cylindrical marine boiler with oil fuel an efficiency of over 83 per cent was obtained, a figure which it is safe to say would be impossible with ordinary coal hand-fired.—*Shipbuilding and Shipping Record.*

British companies are exploring and exploiting wherever possible in all countries where there may be any reasonable chance of finding petroleum, in pursuance of their policy of developing petrol, says *The Review*, the publication of the American Chamber of Commerce in France. The government is aiding navigation companies, new tank steamers are being built, and everywhere the old coal furnaces are being transformed for burning oil.

Personals

H. A. Price, formerly of Talladega, Ala., is now manager of the Texas Power and Light Co., Gainesville, Tex.

C. Wellington Koiner, consulting engineer of Pasadena, California, has been elected a member of the Committee of A. A. E. on Employment.

H. G. Harvey has resigned as commercial engineer of the Nassau Light and Power Co., Mineola, L. I., to take up similar work with the Pennsylvania Utilities Co., Easton, Pa.

E. L. Brandt of Detroit, until recently secretary of the Detroit Chapter of the American Association of Engineers, has been appointed assistant selretary of the national headquarters.

Schuyler R. Ford, formerly chief gunner U. S. N., and an executive officer at the Sayville, N. Y., radio station, has been appointed engineer in charge of the high-power station at New Brunswick, N. J.

R. E. H. Pomeroy has resigned as smelter superintendent of the Nevada Consolidated Copper Co., and will associate himself with the Bonnot Co., Canton, Ohio, as chief engineer of the pulverized-coal department.

W. W. Marshall, superintendent of the Hydro-Electric Power Commission at Orangeville, Ontario, has been appointed town engineer of Orangeville. He will continue as superintendent of the commission.

Kenneth B. Millett, formerly assistant general engineer with the American Thread Co., New York, has resigned to join the organization of the Griscom-Russell Co., New York, in the capacity of development engineer.

Ernest C. Van Winkle, formerly assistant engineer, construction department, of the Chile Exploration Co., New York, has become connected with the Ford, Bacon & Davis Co., New York, in the capacity of valuation engineer.

William H. Dean has been appointed manager of the Chicago Chapter of the American Association of Engineers to fill the vacancy created by the resignation of E. J. Burke, who has entered the newly organized engineering firm of York, Regan and Burke.

Society Affairs

The Association of Iron and Steel Electrical Engineers will hold its annual outing, Saturday, June 5. The program will be announced later.

The American Society of Mechanical Engineers, Philadelphia Section, will hold its annual dinner at the Engineers' Club, Philadelphia, May 25.

The Atlanta Section of the A. S. M. E. will meet in Atlanta, Ga., May 25. J. T. Wikle will present a paper on "The Manufacture of Cotton Goods."

The Association of Iron and Steel Electrical Engineers will hold its fourteenth annual convention in the Hotel Pennsylvania, New York City, Sept. 20-24.

The A. I. & S. E. E., Pittsburgh Section, will have for its subject at the October meeting, "Sheets and Tin Mills," by A. B. Holcomb, general industrial engineer, Messrs. Crippen & Funk, Youngstown, Ohio.

The Pittsburgh Section of the A. I. & S. E. E., will meet in Pittsburgh on June 12. The subject of the meeting will be "Current Limit Reactance," by R. H. Keil, power engineer of the Jones & Laughlin Steel Co.

The American Boiler Manufacturers Association will hold its thirty-second annual convention at the French Lick Springs Hotel, French Lick, Ind., on May 31, June 1 and 2. Matters of importance to the entire boiler-manufacturing industry will be brought before the convention.

The National Association of Stationary Engineers, Iowa State Association, will hold its annual state convention in Dubuque, June 16-18. Besides the business sessions the entertainment committee has arranged for suitable entertainment, including a steamboat excursion on the afternoon of June 16.

The Mid-Continent Section of the A. S. M. E. will meet in Tulsa, Okla., May 28, 29. A delegation will leave the annual spring meeting, which will be held in St. Louis, just before the dates mentioned, to take part in the Tulsa meeting. The visitors will be shown through the zinc mines at Miami and taken on a visit to the oil fields.

The Association of Iron and Steel Electrical Engineers, Pittsburgh Section, will meet on May 22, at Warren, Ohio. An inspection trip will be made to the plant of the Trumbull Steel Co. during the afternoon, and in the evening a paper describing the electrical installations at the plant of the Trumbull Steel Co. will be presented by William F. Rese, electrical engineer.

Engineering Foundation, under the supervision of Charles F. Rand, chairman, is seeking additions to the endowment fund which will swell the total to at least a million dollars in the near future. Through the generous gifts of Ambrose Swasey, Engineering Foundation has, since 1915, been able to actively co-operate in research work with the National Research Council. Mr. Swasey's gifts total $300,000. Additions to the endowment fund will be used to further the research work of the Foundation Societies.

The American Society for Testing Materials will hold its twenty-third annual meeting at Asbury Park, N. J., June 22-25. The headquarters of the meeting will be the New Monterey Hotel. A number of special features, including an informal dance, smoker and a golf tournament, have been arranged. Each of the seven sessions will be devoted to one of the following subjects: Non-ferrous metals, wrought and malleable iron and corrosion, reports of administrative committees, steel, testing apparatus, preservative coatings and lubricants, and miscellaneous committee reports and papers.

The American Institute of Electrical Engineers will hold its annual business meeting in the auditorium of the Engineering Societies Building, New York City, Friday, May 21. The annual report of Directors will be presented, and the report of the tellers' committee announcing the officers elected for the coming year will be read. On this occasion the Edison Medal will be presented to W. L. R. Emmet for inventions and developments of electrical apparatus and prime movers. The medal, its origin and significance, will be described by Carl Herring, chairman, Edison Medal Committee; H. W. Buck will relate the achievements of Mr. Emmet, and Calvert Townley, president of the A. I. E. E., will make the presentation.

Miscellaneous News

The National Screw Thread Commission of the Bureau of Standards, Washington, D. C., created for the purpose of ascertaining and establishing standards for screw threads for use of the various branches of the Federal Government and for the use of manufacturers, has completed a report of its investigations to date. Certain systems of threads are recommended in the report, together with information, data and specifications pertaining to the manufacture of the threads recommended. The commission is composed of S. W. Stratton, chairman; James Hartness, vice chairman; F. O. Wells, E. H. Ehrman, H. T. Herr, E. C. Peck, O. B. Zimmerman, E. J. Marquart, S. M. Robinson and H. W. Bearce. A copy of the report can be obtained from the National Screw Thread Commission, Bureau of Standards, Washington, D. C.

Business Items

Walter N. Polakov & Co., Inc., announce the new location of their offices at 33 West 42nd St., New York City. The offices of the firm were formerly located on Nassau Street.

Nickerson and Collins Co., publishers of trade publications and technical books, announces the removal of the publication office of *Ice and Refrigeration* from South Dearborn St., to 5707 West Lake St., Chicago.

The Dominion Bridge Co. announces the formation of a new company to be known as the Dominion Engineering Works, Ltd. The Bridge company will control the new project, which will engage in the manufacture of waterwheels and other hydraulic machinery.

Trade Catalogs

The Edw. R. Ladew Co., Inc., Glen Cove, New York, has just completed publication of a new fifty-six page catalog, descriptive of the various leather products which they manufacture, including leather belting and packing. A copy can be had on request.

The Lagonda Manufacturing Co., of Springfield, Ohio, manufacturer of steam specialties has ready for distribution a new eight page bulletin, No. T-3: The booklet goes into the subject of cutting tubes out and illustrates the Lagonda Tube cutter as used in different types of boilers and shows in detail how the cutters work. A copy can be obtained on request.

The De Laval Steam Turbine Co., Trenton, New Jersey, has ready for distribution a new 8-page pamphlet entitled "De Laval Centrifugal Pumps for Sugar House Service." Complete information and descriptions of the various types of pumps are contained in the pamphlet, together with illustrations, including centrifugal pumps for handling raw juice, syrup, boiler-feed water and injection water, and for maceration and hydraulic pressure service, etc. Motor and turbine-driven pumps, both single-stage and multi-stage, are illustrated and described. A copy of the pamphlet will be sent on request.

COAL PRICES

Prices of steam coals both anthracite and bituminous, f.o.b. mines, unless otherwise stated, are as follows:

ALANTIC SEABOARD

Anthracite—Coals supplying New York, Philadelphia and Boston:

	Mine
Pea	5.30
Buckwheat	$3.40@$3.75
Rice	2.75@ 3.25
Barley	2.25@ 2.50
Boiler	2.50

Bituminous—Steam sizes supplying New York, Philadelphia and Boston:

Latrobe	$4.25@$4.50
Connellsville coal	4.25@ 4.50
Cambrias and Somersets	4.35@ 5.15
Clearfields	4.00@ 4.75
Pocahontas	6.50@ 7.00
New River	6.50@ 7.00

BUFFALO

Bituminous—Prices f.o.b. Buffalo:

Pittsburgh slack	$6.00
Mine-run	6.25
Lump	6.00@ 6.50
Youghiogheny	6.75

CLEVELAND

Bituminous—Prices f.o.b. mines:

No. 6 slack	$3.25@$4.00
No. 8 slack	4.25
No. 8—¾-in.	3.50@ 4.00
No. 6 mine-run	3.50@ 4.00
No. 8 mine-run	4.50
Pocahontas—Mine-run	3.25@ 4.00

ST. LOUIS

Anthracite—Probably not more than 20 per cent of the demand in this market can be supplied. Prices effective Apr. 1 were as follows:

	Williamson and Franklin Counties	Mt. Olive and Staunton	Standard
Mine-run	$2.65@2.80	$3.00@3.50	$3.00@3.50
Screenings	2.50@2.65	2.50@3.00	2.50@3.00
Lump		3.75@4.50	3.75@4.50

Williamson-Franklin rate to St. Louis is $1.10; Other rates 95c.

CHICAGO

Bituminous—Prices f.o.b. mines:

		Freight rate Chicago
Illinois		
Southern Illinois		
Franklin, Saline and Williamson Counties		
	Mine-Run $3.00@$3.10	$1.55
	Screenings 2.60@ 2.75	1.55
Central Illinois		
Springfield District		
	Mine-Run $2.75@$3.00	$1.32
	Screenings 2.50@ 2.60	1.32
Northern Illinois		
	Mine-Run $3.50@$3.75	$1.24
	Screenings 3.00@ 3.25	1.24
Indiana		
Clinton and Linton		
Fourth Vein		
	Mine-Run $2.75@$2.90	$1.27
	Screenings 2.50@ 2.65	1.27
Knox County Field		
Fifth Vein		
	Mine-Run $2.75@$2.90	$1.37
	Screenings 2.50@ 2.60	1.37
Brazil Block	$4.25@$4.50	$1.27

New Construction

PROPOSED WORK

Mass., Boston—MacNaughton & Robinson, Archts., 101 Tremont St., will soon award the contract for the construction of an 8 story office building on State St., for Henderson & Ross, 148 State St. A steam heating system will be installed in same. Total estimated cost, $300,000.

Mass., Wakefield—The Bd. Educ. will receive bids until May 24 for the construction of a 3 story, 210 x 250 ft. high school on Main St. A steam heating system will be installed in same. Total estimated cost, $450,000. F. I. Cooper Corp., 33 Cornhill St., Boston, Archt.

Conn., Bridgeport — Oskar Krokstedt, Archt., 925 Main St., will soon award the contract for the construction of a 2 story, 130 x 147 ft. garage addition on State St. A steam heating system will be installed in same. Total estimated cost, $150,000. Owner's name withheld.

N. Y., Brooklyn—The Brooklyn Edison Co., 360 Pearl St., plans to build a 1 story sub-station on Grand St. Estimated cost, $100,000. William Whitehill, 55 Duane St., New York City, Archt. and Engr.

N. Y., Buffalo—The Beaver Board Co., Military Rd., is in the market for one or two 230 lb. 125 hp., steam pressure boilers, (used).

N. Y., Buffalo—Philip Begy, 296 Baynes St., is in the market for a boiler and pump for the Hoffman Pressing Machine.

N. Y., Buffalo—The Stewart Motor Corp., 413 East Delavan Ave., is in the market for an air compressor outfit with tank.

N. Y., Dunkirk—The City voted $22,000 bonds to install a heating plant in the Jones General Hospital here. Work includes the construction of a 43 x 50 ft. boiler house, etc.

N. Y., New York—The Bd. Educ., 500 Park Ave., will receive bids until May 22 for the construction of a 4 story, 92 x 194 ft. school building on 182nd St. and Bathgate Ave. A steam heating system will be installed in same. Total estimated cost, $420,000. C. B. J. Snyder, Municipal Bldg., Archt. and Engr.

N. Y., New York — Maurice Courland, Archt. and Engr., 47 West 34th St., plans to build an 18 story factory. A steam heating system will be installed in same. Total estimated cost, $1,200,000. Owner's name withheld.

N. Y., New York — J. A. Hearns Sons, Inc., 20 West 14th St., is having plans prepared for the construction of a 2 story, 50 x 135 ft. boiler plant at 26 West 13th St. A steam heating system will be installed in same. Total estimated cost, $135,000. Densmore & Le Clear, 88 Broad St., Boston, Mass., Archts. and Engrs.

N. J., Burlington—G. A. Allinson, Supt. of the Waterworks, will soon award the contract for the installation of high service pumping machinery for water plant in one 3,000,000 gal unit. W. H. Boardman, 426 Walnut St., Philadelphia, Pa., Engr.

N. J., Camden—The Victor Talking Machine, Front and Cooper Sts., plans to build a 4 story warehouse on State, York, Pine and Front Sts. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Ballenger & Perrot, 329 South Broad St., Philadelphia, Pa., Archts. and Engrs.

N. J., Vineland—F. H. Bent, 142 West State St., Trenton, plans to construct a 1 story, 50 x 75 ft. storehouse and refrigerator plant, here. Machinery will be installed in same. Total estimated cost, $30,000.

Pa. Lock Haven—The city will receive bids until June 1 for the installation of an electric booster pump, etc. in connection with the proposed waterworks improvements. Total estimated cost, $80,000. D. E. Oberheim, City Clk. H. P. Shoemaker, Engr.

Pa., Philadelphia — Horace Trumbauer, Archt., Land Title Bldg., will soon award the contract for the construction of a 12 story, 60 x 90 ft. office building on 17th and Cherry Sts. and the Parkway, for the Sun Oil Co., Finance Bldg. A steam heating system will be installed in same.

Md., Baltimore—The Bd. of Awards will receive bids until May 26 for the construction of a 3 story, 150 x 200 ft. public school on Poplar Grove St. and Lafayette Ave. A steam heating system will be installed in same. Total estimated cost, $250,000. H. Adams, Calvert Bldg., Engr. E. H. Glidden, 1210 American Bldg., Archt.

Md., Baltimore—The Capitol Theatre Co., 719 Fidelity Bldg., is having plans prepared for the construction of a 1 story, 120 x 200 ft. theatre at 1518-1522 West Baltimore St. A steam heating furnace will be installed in same. Total estimated cost, $250,000. Wyatt & Nolting, 1012 Keyser Bldg., Archts.

N. C., Winston-Salem — The Memorial Hospital is receiving bids for the construction of a 2, 3, 4 and 5 story hospital building. A steam heating system will be installed in same. Total estimated cost, $800,000. Charles R. Keen, Bailey Bldg., Philadelphia, Pa., Archt.

Ga., Metter—The town voted $35,000 bonds for the construction of a waterworks system and pumping plant. L. C. Anderson, Mayor.

O., Akron—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., will receive bids until June 1 for the installation of a boiler.

O., Cincinnati—A. S. Taft, 316 Pike St., is receiving bids for the construction of a 10 story, 40 x 60 ft. addition to power building, on 8th and Sycamore Sts. Harry Hake, Telephone Bldg., Archt.

O., Cleveland—The Bd. Educ., 6th St. and Rockwell Ave., received bids for the installation of a heating and ventilating system in the proposed school on East 92nd St. and Parkgate Ave., from the J. Roemer Heating Co., 1808 East 22nd St., $159,491. Noted March 16.

O., Cleveland—The Hausheer Sloan Co., Sloan Bldg., has purchased a site on East 18th St. and Euclid Ave. and plans to build a 12 or 16 story, 130 x 190 ft. commercial building on same. A steam heating system will be installed in same. Total estimated cost, $500,000. T. E. Sloan, Treas.

O., Cleveland — The Hebrew Orthodox Home for the Aged, Inc., c/o S. H. White, Archt., 1032 Schofield Bldg., will receive bids until June 2 for the construction of a 2 story, 130 x 150 ft. home for the infirm at 736 Lakeview Rd. A steam heating system will be installed in same. Total estimated cost, $250,000.

O., Cleveland Heights (Warrensville P. O.)—The Bd. Educ. plans an election May 22 to vote on $2,400,000 bonds to construct 3 story school buildings on Fairfax, Coventry and Noble Rds. Steam heating systems will be installed in same.

O., Columbus—The city rejected all bids for the construction of a pumping station for the Shepard main line trunk sewer and for the installation of equipment. Work will be readvertised.

O., East Cleveland—The Bd. Educ. will receive bids until May 24 for furnishing and installing power equipment, including a brick stack, two 300 hp. boilers and piping for the boiler house. Total estimated cost, $25,000. C. Ammerman, Williamson Bldg., Cleveland, Clk. Bishop & Babcock Co., East 55th St., Cleveland, Engrs.

O., East Cleveland—The Park Congregational Church, 11111 Ashbury Ave., Cleveland, plans to build a 1 story church on Lockwood and Euclid Aves. A steam heating system will be installed in same. Total estimated cost, $300,000. Rev. Talbot, Pastor. I. W. Corbusier, Lennox Bldg., Cleveland, Archt.

O., Norwalk—The city plans to install a 1,000 kw. generator in the power station.

O., Wooster — The town voted $60,000 bonds to construct a pumping station, extension to water mains, etc. H. H. Miller Serv. Dir., C. O. Williamson, Engr.

Mich., Detroit—Richard H. Marr, Archt. 435 Woodward Ave., will receive bids until May 25 for the construction of a 2 story, 100 x 130 ft. publishing house on Howard and 6th Sts., for the Sprague Publishing Co., 150 Lafayette Blvd. A steam heating system will be installed in same. Total estimated cost, $110,000.

Mich., Detroit—J. I. Weinberg, Archt., 401-403 Congress Bldg., will soon award the contract for the construction of a 1 story, 100 x 180 ft. factory on Grand Blvd. and Moran St., for Jacob Shevitz, 195 Ferry Park. A steam heating system will be installed in same. Total estimated cost, $125,000.

Mich., Ironwood — Alvord & Burdick, Engrs., 8 South Dearborn St., Chicago, will soon award the contract for the construction of additions to ground water supply and installation of electrical equipment, etc., for the city. Total estimated cost, $300,000.

Ill., Chicago—The Illinois Malleable Iron Co., 1801 Diversey Blvd., is having plans prepared for the construction of a 11 story building. Two 300 hp. boilers, air compressor, stokers, and ash handling equipment will be installed in same. Cahill & Douglas, 217 West Water St., Milwaukee, Wis., Engrs.

Ill., Chicago—George C. Nimmons & Co., Archt., 104 South Michigan Ave., will soon award the contract for the construction of a 1 and 2 story, 135 x 400 ft. factory for the manufacture of metal products, on Taylor and Campbell Sts., for the Harrington & King Perforating Co., 614 North Union Ave. A steam heating system will be installed in same. Total estimated cost, $275,000.

Ill., Chicago—William G. Rosenberger, 214 West Ontario St., is having plans prepared for the construction of a 3 story, 80 x 100 ft. cigar box factory on La Salle and Ontario Sts. A steam heating system will be installed in same. Total estimated cost, $250,000. Alfred S. Alschuler, 28 East Jackson St., Archt.

Minn., Minneapolis—The Bd. Educ. received bids for the installation of a heating and ventilating system in the proposed schools on (A) Harriet Ave. and 38th St., from Bjorman Bros., 712 South 10th St., $46,938; (B) 31st St. and 29th Ave., $44,942; (C) 22nd Ave., S. E. and 40th St., $49,808, and from H Kelly & Co., 925 Plymouth Bldg., (A) $49,200, (B) $47,140, (C) $49,349. Noted March 30.

Kan., Newton—Bethany College plans to build a heating plant, dormitory, etc., here. Total estimated cost, $500,000. Lorenz A. Schmidt & Co., 121 North Market St., Wichita, Archt.

Wyo., Casper — Garbutt, Weddner & Sweeney, Archts., Oil Exch. Bldg., will receive bids until June 1 for the construction of a 6 story banking and office building on Wolcott and East 2nd Sts., for the Wyoming Natl. Bank. A steam heating system will be installed in same. Total estimated cost, $375,000.

Mo., St. Louis—The Joseph Greenspon's Sons Iron & Steel Co., 3130 Hall St., is in the market for 2 cross compound condensing, 1,000 hp., with direct connected generators, 440 volt, a.c. Corliss engines.

Tex., Clyde—The town plans to furnish, and install pump and power equipment, etc.

Tex., Fort Bliss—The Construction Division, Quartermaster Corp., will receive bids until May 31 for the construction of hospital building including a central heating plant, etc.

Utah, Farmington—The Davis Co. Irrigation Dept., plans to build a hydro-electric plant to develop 10,000 hp., dam, etc. Total estimated cost, $2,331,000. A. T. Parker, 585 28th St., Ogden, Engr.

Cal., Los Angeles—Mary Spires, c/o J. C. Austin, Archt., 1121 Baker-Detwiler Bldg., is having plans prepared for the construction of a 2 story, 130 x 150 ft. stores and dance hall on 6th and Olive Sts. A plenum heating system will be installed in same. Total estimated cost, $235,000.

Cal., Mare Island—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to install a heating system in the structural shop, here. Estimated cost, $60,000.

Cal., San Diego—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to construct a refrigeration plant at the Marine Corps base, here. Estimated cost, $50,000.

N. F., St. Pierre—The Minister of Pub. Works will soon award the contract for furnishing one 500 hp. boiler, four 600 hp. boilers, one 25 hp. dredge, etc.

Que., Montreal—The Montreal Harbor Comn. will receive bids until May 21 for the construction or an 8 story, 110 x 400 ft. cold storage warehouse. Refrigeration machinery will be installed in same. Total estimated cost, $1,000,000. F. W. Cowrie, 731 Sherbrooke, W., Engr.

Que., Montreal — The Montreal Harbor Comrs., will soon receive bids for the construction of a 50 x 150 ft. power house. Estimated cost, $150,000. F. W. Cowrie, 731 Sherbrooke, W., Engr.

Ont. London—The Bd. Educ. plans to build a high school on Waterloo St. A steam heating and ventilating system will be installed in same. Total estimated cost, $500,000. A. A. Langford, Chn. L. E. Carrothers, Archt.

Ont., Newmarket—E. A. James Co. Ltd., will receive bids until May 25 for the construction of an outfall sewer, disposal and an activated sludge plant, pumphouse, and compressor house including compressors, for the city. Total estimated cost, $65,000. Noted Jan. 27.

Ont., Peterboro—The city is having plans prepared for a sewage disposal station and pumping plant. Air lifts will probably be installed in same. Total estimated cost, $50,000. R. H. Parsons, City Hall, Engr.

Ont., Port Credit—The village plans to construct a waterworks system. Plans include an intake into Lake Ontario, pumphouse, pumps, mechanical filters, chlorination, elevated tank, etc. Total estimated cost, $80,000. E. A. James Co. Ltd., 36 Toronto St., Toronto, Engr.

Ont., Windsor—The city of Windsor and other municipalities plan to build a 4 story civic building. A steam heating system will be installed in same. Total estimated cost, $1,500,000. F. L. Howell, 82 Caron St., Alderman.

CONTRACTS AWARDED

Mass., Malden (Boston P. O.)—The Malden Savings Bank has awarded the contract for the construction of a 2 story, 52 x 93 ft. bank building on Malden Sq., to the Gascoigne & Lindenthal Co., 43 Tremont St., Boston. Contract for installing heating system will be sublet. Total estimated cost $150,000.

Conn., New Haven—The United Illuminating Co., 84 Temple St., has awarded the contract for the construction of a 1 story, 70 x 75 ft. turbine room extension, to C. W. Murdock, Inc., 185 Church St. and a boiler room extension to Westcott & Mapes, Inc., 207 Orange St.

N. Y., Brooklyn—The Brooklyn Jewish Recreation Center, 881 Eastern Parkway, will build a 3 story, 125 x 187 ft. recreation center on Eastern Parkway. A steam heating system will be installed in same. Total estimated cost, $750,000. Work will be done by day labor.

N. Y., Long Island City — The Municipal Studio Corp., 41st St. and Bway., New York City, will build a 200 x 600 ft. studio on Pierce, 8th, 9th and Washington Sts. A steam heating system will be installed in same. Total estimated cost, $2,000,000. Work will be done by day labor.

N. Y., New York—The Chatham & Phoenix Natl. Bank, 149 Bowery St., has awarded the contract for the construction of a 60 x 100 ft. bank building at 118-122 Bowery St., to the Tidewater Bldg. Co., 16 East 33rd St. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. Y., New York—Severlace & Van Allen, Archts. and Engrs., 111 East 40th St., will build a 16 story, 60 x 126 ft. office building on 41st St. and Lexington Ave. A steam heating system will be installed in same. Total estimated cost, $500,000. Work will be done by day labor.

N. Y., New York—The Fifth Ave Hospital, 67th St. and Park Ave., has awarded the contract for the construction of a 9 story hospital at 105th-106th Sts. and 5th Ave., to Marcus Eidlitz, 30 East 41st St. A steam heating system will be installed in same. Total estimated cost, $2,500,000.

N. J., Newark—John Campbell & Co., 75 Hudson St., New York City, has awarded the contract for the construction of a 1 story, 91 x 233 ft. dye building and power house on Plum Point Lane, to James Jewks & Sons, 676 Montgomery St., Jersey City. A steam heating system will be installed in same.

Md., Baltimore—The Bailey Bldg. Co., Munsey Bldg., has awarded the contract for the construction of a 25 story, 75 x 100 ft. office building on Lexington and Calvert Aves., to Norton, Bird & Whitman, 616 Munsey Bldg. Oil burning boilers for heating system will be installed in same. Total estimated cost, $2,500,000.

O., Cleveland—The B. F. Keith Theatre Co., 1564 B'way, New York City, has awarded the contract for the construction of a 1 story theatre on East 105th St. and Euclid Ave., to Lundoff Bicknell Co., 5716 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $600,000.

O., Marion—The Bd. Educ. has awarded the contract for the installation of a heating system, to the Jones-Kinn Eng. Co., 414 North Main St., Lima, at $11,900.

O., Shaker Heights (Cleveland P. O.)—The Shaker Heights Hospital, c/o M. Loeser, 800 Natl. City Bldg., Cleveland, has awarded the contract for the construction of a 3 story hospital to the Crowell Little Constr. Co., East 57th St. and Euclid Ave. Cleve-. nd. A steam heating system will be installed in same. Total estimated cost, $250,000.

Mich., Battle Creek—The Clark Equipment Co., Buchanan, has awarded the contract for the construction of a 1 story, 190 x 450 ft. axle plant on Springfield Place and the Michigan Central Ry., to Bates & Rogers, Chicago. Steam heating equipment will be installed in same.

Mich., Detroit—F. L. & Angus Smith, 1905 Dime Bank Bldg., has awarded the contract for the construction of a 2 story, 93 x 220 ft. garage on Woodward Ave. near Parsons St., to Otto Misch, Chamber of Commerce Bldg. A steam heating system will be installed in same. Total estimated cost, $135,000.

Mich., Detroit—Morgan & Wright, Bellevue Ave., has awarded the contract for the construction of a 9 story 326 x 456 ft. tire factory and warehouse on Jefferson Ave., to the Stone & Webster Corp., Book Bldg. A steam heating system and electric power will be supplied from detached central plant under contract. Total estimated cost, $4,000,000.

Mich., Lansing—The city has awarded the contract for the construction of a 250,000 gal. reservoir and installation of air lift and an electric air compressor, to the Ellington Miller Co., 417 South Dearborn St., Chicago. Total estimated cost, $75,000. Noted April 6.

Ill., Chicago—The Transo Envelope Co., 3550 Kimball Ave., has awarded the contract for the construction of a 1 story, 210 x 350 ft. envelope factory on Kimball Ave. near Addison St., to O. W. Rosenthal Co., 80 East Jackson St. A steam heating system will be installed in same. Total estimated cost, $275,000.

Wis., Manitowoc—The Spindler Co. has awarded the contract for the construction of a 2 story, 60 x 130 ft. artifical ice plant to Ben Herman & Son.

Wis., Milwaukee—Geuder, Paeschke & Frey, 152 St. Paul Ave. and 15th St., have awarded the contract for the construction of a 1 story, 75 x 100 ft. power plant on St. Paul Ave., to the Meredith Bros., 1043 Kinnickinnic Ave., installation of boilers, to the Babcock & Wilcox Co., 567 Lake St., Chicago, stokers, to the Combustion Eng. Co., 11 Bway., New York City. Noted March 3.

Wis., Milwaukee—The School Bd., 10th and Prairie Sts., has awarded the contract for the installation of a heating system including boilers in the proposed boiler house on Garfield Ave., to the Industrial Heating & Eng. Co., 143 Oneida St., at $28,100. Noted May 3.

Ia., Ottumwa — The Y. M. C. A. has awarded the contract for the construction of a 4 story, 60 x 99 ft. Y. M. C. A. building, to the Wells Bros. Constr. Co., 411 South Union St., Chicago. A steam heating system will be installed in same. Total estimated cost, $350,000.

Minn., Buhl—The Bd. Educ. has awarded the contract for the construction of a 3 story, 148 x 275 ft. addition to the high school to the Natl. Constr. Co., Virginia St. A steam heating and mechanical ventilating system will be installed in same. Total estimated cost, $250,000.

Minn., Hibbing — The Bd. Educ. has awarded the contract for the construction of a 3 story, 174 x 417 ft. high school on 3rd St., to the Jacobson Bros., Columbia Bldg., Duluth, at $579,500. A steam heating and mechanical ventilating system will be installed in same.

Tex., Eastland — C. M. Connelley will build an 8 story hotel to include a power plant. Total estimated cost, $300,000. Work will be done by day labor.

Col., Boulder—The University of Colorado will build a 3 story, 50 x 275 ft. college building. A steam heating system will be installed in same. Work will be done by day labor.

Que., Montreal — The Administrative Comn., City Hall, has awarded the contract for the manufacture and installation of one 30,000,000 gal. pump for the low level pumping station, to the Fraser Chalmers Co. at $50,250; another electric driven pump to E. Laurie & Co., 243 Bleury St., at $45,200; transformers and commutators necessary for the operation of the pumps, to the Canadian General Electric Co., 162 St. Antoine St., at $48,640. Noted March 9.

Ont., Sault Ste. Marie—The Algoma Steel Corp. has awarded the contract for installing a.c. motor equipment in connection with the $7,000,000 structural steel plant extension, here, to the Canadian General Electric Co., King and Simcoe Sts., Toronto, and for d.c. motor equipment and main motor drives to the Canadian Westinghouse Co., Hamilton.